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West Europe Report

SCIENCE AND TECHNOLOGY

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AEROSPACE

FRG OPINION ON SPACELAB BENEFITS, SPACE STATION PARTICIPATION

Stuttgart BILD DER WISSENSCHAFT in German May 84 pp 48-55

[Article by Berndt Feuerbacher*: "The New Space Station: Is Space Flight Worthwhile?"]

[Text] Astronautics

Do the information and results gained from astronautics match their immense cost? Can we afford space travel at all? What is the historic role of Spacelab in manned space flight? Where do we go from here? Wolfram Knapp, editor of BILD DER WISSENSCHAFT, has discussed these things with the astronautic scientist Prof Dr Berndt Feuerbacher at the DFVLR [German Research and Testing Institute for Aeronautics and Astronautics] in Cologne. This first article was the product of that conversation. The minister for research and technology, Dr Heinz Riesenhuber, and the physicist, Dr Peter Kafka, of the Max Planck Institute for Astrophysics in Garching near Munich also responded to the same questions.

Spacelab was a scientific success--without any doubt. But Spacelab was also very expensive. Too expensive? Can we afford this luxury? One hears these questions repeatedly and they are justified. But they are not to be answered simply with a "yes" or "no."

Spacelab is a large-scale research instrument. One can compare it in every respect with DESY in Hamburg. The Spacelab experiment encompasses many different research areas; here, too, much work is being done in the laboratories.

It is hard to judge the scientific need for Spacelab. In none of the many specialized areas is the space laboratory absolutely requisite. On the other hand the potentialities of outer space are indispensable for certain individual research projects. X-ray astronomy, for example, cannot be conducted on

* Born in 1940 in Dresden, studied physics in Munich and received his degree while working with the Synchrotron at DESY in Hamburg. After that he worked as project scientist for Spacelab 1 at ESA. In 1981 Feuerbacher accepted a joint call from the DFVLR and the Ruhr University in Bochum. Since then he has been director of the Institute for Space Simulation at the DFVLR in Cologne-Porz and at the same time has occupied a chair at the Institute for Space Physics at Bochum University.

earth but only in outer space. The science of materials can be pursued in the laboratory and the same is true of the biological sciences; atmospheric physics can be done with balloons. And so could we not have done without this costly enterprise?

No--unless we want to do without research altogether. In many disciplines there were important experiments. But one cannot point to one specific discipline and say for this discipline Spacelab was absolutely necessary.

We are indebted to Spacelab for important advances in various directions. One of the most important is atmospheric physics. The "cricket spectrometer," for example, has made high resolution measurements of molecular spectra. It has found a whole series of new molecules in the upper atmosphere which previously had not been suspected, at altitudes of from 80 to 150 km. In this area we now have an inventory which had previously been lacking.

But what has been the actual advantage of getting to know these molecules? The same experiment will fly once again in 1985 with the earth observation mission (EOM). After that one will be in a position to make comparisons with the Spacelab measurements; thus it will be possible to observe changes in the upper atmosphere. In this way one can determine the effect of pollution in the upper atmosphere resulting from effects which we have produced in the lower atmosphere. Up to the ozone layer we had previously known the atmosphere quite well. But beyond that we knew very little--previously, before Spacelab.

The experiments in the domain of medicine were very informative. It is true that a lot has been publicized with some exaggeration. There were voices which even declared that it would now be necessary to rewrite the textbooks. Perhaps it might be necessary to supplement them--but there is no need to talk about rewriting.

Frequently one hears the criticism that we have no need for space-live-science because after all we do not live in outer space. But this criticism is not to the point. Many investigations have been undertaken which are important for problems on earth. The results of Spacelab have, for example, significantly enriched our knowledge of earthly medicine.

The first flight of Spacelab was aimed primarily at demonstrating the utility of this device. In this it was successful but it also showed how useful and necessary the on-board scientist is. There were more experiments installed in Spacelab 1 than were flown by the European space organization ESA in 20 years on all scientific satellites.

Spacelab will not fly only once. Nor were the experiments created and set up only for this one flight. At the German Research and Testing Institute for Aeronautics and Astronautics (DFVLR) we have performed numerous experiments for the next big mission--for D 1. While D 1 is an abbreviation for Germany, nevertheless only about 80 percent of the experiments are of German origin. The D means primarily that this mission is running under German responsibility. The ESA is in charge of a whole series of experiments and in addition there is also American participation.

The Americans have a fairly large block of experiments on D 1 bearing the name "MEA" (Materials Experiment Assembly). Essentially these are automatically conducted experiments in materials science.

One often hears the reproach that with Spacelab the Americans have "put one over on us": we built Spacelab and are subsequently handing it over to the Americans.

When Europe was urged by the Americans to participate in the shuttle program there were at first a variety of projects: for example, a "tender" which would transport equipment back and forth in the orbit. At that time Europe was hesitant. The projects steadily shrunk until finally Spacelab was all that remained. At that time we were not in a very favorable negotiating position.

As a result of all this Spacelab was given to the Americans and to balance this we paid only half the launching costs. This second part of the agreement has been terminated with the first Spacelab flight. We must make full payment for all subsequent flights.

But: in the agreement NASA has also obligated itself to undertake no parallel or equivalent development. And now NASA has, nevertheless, ordered two Spacelabs from Erno--paid-up orders for which a heap of dollars are flowing in our direction.

What is still more important is the fact that by getting on board in this way we are now, when the space station is being discussed, an important partner in the negotiations. We have shown that we can handle the technology--Spacelab has performed fantastically. We can speak with an equal voice in manned space flight. But what has this image and this celebrity cost us?

The cost of Spacelab altogether was about 2 billion marks. This has been expended over a period of 10 years from 1974 to 1984. These costs include planning, development, construction and flight. The German share in this amounted to about 50 percent--in other words not quite 2 marks annually per citizen of the FRG.

In replying to the question as to whether we can still afford manned space flight it might be said that Spacelab could be classed as a cultural luxury which we can afford and which we should afford. Because science at its core, real basic research, is in fact a form of culture. When we study astrophysics and when we investigate the X-ray radiation of the sky then that is certainly something from which we have no right to demand the famous Teflon frying pan. But such research constitutes a cultural advance.

If under this aspect we examine the development of space travel as a whole we find that it began with an investigation of space itself, the near environment of the earth and the remote environment. In the course of this we have also directed our glance back at the earth in order to examine it also and in order to map it. With Spacelab we have taken a further step from exploration of space to research in space.

Today the foreground is occupied by physics, chemistry and medicine--and also by observations of the earth in space and from the point of view of space. We use space as a special form of laboratory, very much as we use a large accelerator as a special laboratory. This is the case for medicine, for technological process investigations, for the physics of fluids and for solid-state physics.

And what now is to be said regarding the much-cited industrialization of space? Is it a question of basic research or is it also a question of the production of exotic materials in significant quantities? There has in fact already been a promise of the manufacture of special turbine blades in outer space.

This is rather similar to what one finds in fusion research: the researchers are always promising that they will reach their goal in about 20 years. This is regardless of when they are asked.

Possibly we shall never manufacture mass-produced products in outer space. The things produced there will probably always be very special items of which small quantities are required, very expensive items such as, for example, semiconductors having quite special properties.

Thus, for example, when one needs semiconductor crystals which are required to be extremely defect-free and which are to have uniform dosage, in order to be able to manufacture from them special smaller and more precise switching elements then presumably these will be needed only in small quantities. This sort of thing would be manufactured in orbit: small in quantity and unusual in nature. But probably alloys will never be produced by the ton. Many ambitious goals which were pursued in the beginning are now seen more realistically. Much of this sort of thing has been very emphatically retracted.

D 1 will be the second flight of Spacelab. After that there will still be some further flights. For D 2 the first preparations are already in progress. The Americans plan a series of internationally manned Spacelab flights for which they are already examining experiment proposals from all countries. Those proposals which they accept are flown free of charge.

In these Spacelab researches, in the experiments in so many disciplines a certain far-ranging sequence may be seen extending to the space station.

As of 1992--according to American plans for the astronautical future--a permanent space station will be circling in space. Then the question might come up again as to whether it would not be worthwhile to carry out mass production of certain materials there?

Even in the case of a station which is continuously circling there is a question with regard to transport. And also it will be a success for Spacelab and the subsequent missions if we learn how materials can be improved on earth. Consider semiconductor technology:

In the meantime we are able on earth to produce silicon monocrystals up to 15 cm in diameter. This means that we do not have any urgent need of outer space in order to manufacture semiconductor materials. On the other hand, however, there exist crystals which cannot be properly grown under gravity. This is where outer space plays its role.

In addition, there is a European idea which is as fascinating as it is ambitious: Columbus. A research laboratory is decoupled from the space station to fly freely next to the station. This station is completely undisturbed by any movements and maneuvers by the mother ship.

The activities of the astronauts, in particular, have continuously exerted small gravitational thrusts upon the space ship. Spacelab in other words has not been entirely weightless; there have always been accelerating impulses. Columbus on the other hand is absolutely undisturbed. Here experiments can proceed without external influence.

Now and then Columbus is visited by astronauts from the neighboring space station. For example, they remove finished products from it, reload the station, construct new experiments and then return leaving Columbus alone to fly on undisturbed.

This Columbus project is a joint initiative by Italy and the FRG. At the present time work is being done on the planning; after that the project is to be introduced at the ESA. The ESA has a positive attitude toward this project. Columbus could be a part, a European part, of the planned American station in space.

Back to Spacelab: Spacelab 1 was multidisciplinary. The aim was to demonstrate that the space laboratory can serve as a working platform for many disciplines.

But: it would be totally illogical to collect, as was done on this first flight, a number of disciplines all at once also on future large space ships.

The reason is simple. Some of them get in the way. The researchers in micrograviation want to have as few disturbances as possible and thus their watchword is: no maneuvering if at all possible. On the other hand, to them the attitude of the space ship is unimportant.

The astrophysicists want their telescopes directed toward outer space. The earth observers want to look down toward the earth. The atmospheric physicists want to look horizontally. But it's impossible to do all of this at once. This means that one would have to continuously rotate the orbiter into a different direction. In the case of the Spacelab flight there were over 200 such maneuvers. This--from the point of view of certain experiments--is ridiculously many.

For this reason the June 1985 shuttle--the earth observation mission with the cricket spectrometer on board once again--will be aimed almost exclusively with its opening downward, in other words in the direction of the earth.

This mission D 1, with its predominantly German setup, is primarily devoted to the study of microgravitation. This relates to the life sciences and the science of materials. The shuttle will change its attitude as little as possible.

The American Spacelab 2 will be directed "outward" toward the cosmos--at the request of the astrophysicists and plasma physicists.

And so in the future there will be much more orientation toward specific disciplines. The scientist-astronauts on the flight will be highly specialized experts in the particular field. The West German scientist Dr Ulf Merbold was in the case of many Spacelab 1 experiments always in a position to apply his own scientific judgment, for example, in the domain of solid-state physics. In other fields he had to "bone up" in advance.

In America at the present time there is discussion as to whether one might not better use automated space stations. Thus, for example, R. Eshleman, a radioastronomer from Stanford, advanced the view that astronauts are not unconditionally necessary in space, that science and technological research would profit more if robots having artificial intelligence were employed and guided from the ground. Are scientists in outer space a too costly luxury?

The classical space sciences do not absolutely require manned space flight. But for new forms of research with the earthly laboratory located in outer space it is important that scientists should fly along.

With respect to this area we are still in an experimental stage. We can still not precisely estimate the possibilities which may open up in this new and gigantic laboratory.

In outer space one must always allow for the possibility of discovering something entirely new. Just for this reason alone it makes sense for a scientist to be on the spot. The space station will open up a new dimension in research possibilities. Spacelab was only a step in that direction--but an important and productive one.

[Box, pp 54-55]

The German Federal Minister for Research and Technology, Dr H. Riesenhuber, on the Subject of Space Travel

BILD DER WISSENSCHAFT editor Anne-Lydia Edingshaus asks the German federal minister for research and technology, Dr Heinz Riesenhuber: "Can we really afford space travel, can we pay for it?"

This question is very complex. It encompasses our entire space program. The projects are not basically beyond our reach. And here when I say "our" I mean Germany together with its European partners.

Just how much priority these space projects have and just what the proportion is between cost and usefulness for science and industry are questions which we must now examine very carefully. Only then can we make a decision.

If we are to participate in a space station then I should like this to be under really good conditions. In the case of Spacelab these conditions were not quite optimal.

At the present time out of our approximately 7-billion-mark budget we are putting about 770 million marks into space research. This is a very large amount which also makes possible a very large number of different studies. About half of it is being put into projects within ESA jointly with our European partners.

What we are going to do in the next 10 years can only be logically appraised against the background of the last 10 years. During that time we have brought some of the big projects to a successful conclusion. Ariane under French leadership has been carried over with Ariane-space into commercial exploitation. Here new power plants are still a fruitful topic of discussion--and thought is being given to this topic.

Designs for future Ariane versions can also be developed. Work is being done on this, too. Now it is possible for us to lay the groundwork for a new strategy.

Spacelab was the other very successful big project. It included a number of scientific projects. Other projects such as, for example, the ESA-Meteosat have been put to practical use and transferred to the users. As a result of the completion of Ariane and Spacelab, the two large system projects of ESA, we have acquired a new financial dimension in our overall planning. But this doesn't mean that we suddenly have a gap in the budget. The budgets are being continuously rewritten because other projects are always at different stages of development.

We must now consider the ensuing phases of Spacelab. Preparations are under way for the next flight with its corresponding experiments. We must jointly determine with science and with economics just what new experiment designs should follow the first successful Spacelab flight in its next phase.

NASA's space station offer was presented to me orally by its director James M. Beggs. We shall receive it later in writing. It is a remarkably flexible offer: the Americans speak of total costs of $10.5 billion in escalated prices over the entire period of construction. The European share would here be about 25 percent.

But what that now means in detail can still not be precisely stated at the present time. NASA emphasizes expressly that we are still in a phase in which we can cooperate with them in design definition. This could, for example, be a contribution to the total system in the form in which it has up to now been undertaken by NASA as a basic concept.

But we might also make an additional contribution perhaps in the form of a coupleable module. This would give rise to a variety of engineering designs with a variety of costs.

If Spacelab were to be continued, under the title of Project Columbus, to a module in space--although that would still call for large engineering breakthroughs--the cost of such a module would on the basis of present estimates be about 1.5 billion marks. This would have the consequence that under the present financial arrangement we would be making a contribution of about 40 percent to the space station. This is approximately of the order of magnitude of an annual budget for space research and a magnitude which we could certainly still handle. But we would be expending this for a project which will fly in 1992 at the earliest.

But there are also other more expensive projects. For example, a continuation of Spacelab toward the development of a module which stays permanently in space with its own life-support systems and so forth.

According to NASA the space station design would have to be ready in 2 years. That would mean that we would have a voice here. We would be expected within about a year to have completed a first, but still neatly nailed down, synopsis ready.

Of course, in this there could be various studies running in parallel. This, for example, would be the case in examining alternatives for space vehicles, platform, space station, satellites or rockets. In parallel with these there would also have to be studies of user requirements and of possible experiments.

After the expiration of 1 year there is to be for us and our European partners an interim balance. Then after that we shall move into a more concrete design phase.

At the present time we are intensively inquiring as to just what alternative projects there may be and what projects can be especially useful for possible applications-oriented science in industry.

We have required NASA to communicate to us all possible industrial applications of a permanent space station so that we may determine whether similar proposals might not also be of interest to our industries.

We are already talking--with inclusion of the results of the Spacelab flight--with our industry in order to determine whether our industry has any ideas concerning the way in which such a permanent space station might be envisioned and used as a laboratory or perhaps even as a production facility over a very long period. What we have up to now achieved in materials research or pharmaceutical experiments with Spacelab has been no more than a point of departure.

We are conducting the same discussion with scientists. We asked them to tell us what useful studies can be carried out in space using structures cheaper than a permanent space station? For example, perhaps with a platform or with a combination of platform and Spacelab or even in certain cases with satellites. Or with the TEXUS experiments which produce weightlessness for a few minutes; this is a length of time which is entirely adequate for many experiments.

Out of these elements we have to construct an evaluation both of the utility of the space station and also of the utility of alternative concepts.

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FRENCH CNES OFFICIAL DESCRIBES ARIANE V LAUNCHER

Paris L'AERONAUTIQUE ET L'ASTRONAUTIQUE in French No 105, 1984-2 pp 24-31

[Article by R. Vignelles, manager of launchers, CNES [National Space Studies Center]-91000 Evry; subheading numbering provided by translator]

[Text] I. Need for a New Launcher

1. Present and Intermediate-Term Situation Regarding European Launching Vehicles

Ten years ago, Europe committed itself to developing the Ariane launcher, the key to its independence with regard to commercial use of its telecommunications satellites.

The rapid growth in the need for spaceborne applications worldwide (telecommunications, TV broadcasting, earth observation) resulted in a spectacular growth of the world market for satellites, hence for the means of launching them. Thus, to the initial political objective was added, for Ariane, a commercial objective: A share of the international market for launchings.

The attainment of this objective required, on the one hand, the putting in place of a structure capable of producing and marketing the launcher, and on the other hand, a constant upgrading of Ariane in step with the market, as much from the standpoint of the evolution of satellites (in weight and size) as from that of launching costs. Thus, Ariane was equipped with SYLDA [Ariane Double-Launching System] (bringing down the launching cost per satellite), and is now undergoing progressive improvements in its performance ratings and payload volumetric capacity (Ariane succession).

That is the present situation: The Ariane launcher is beginning its commercial career. A number of double launchings have been programmed. In 1984, the Ariane 2 and 3 versions will be put into service. In 1986, Europe will have at its disposal the Ariane 4 launcher, whose adaptability, weight-carrying and volmetric capacity, and competitiveness will enable it to cope convincingly with American competition and principally the Space Shuttle, which by then will have reached full operational maturity.

Thus, the European launching capability is assured over the near and intermediate terms.

Its longer-term capability (beyond 1992-1994) will necessarily diminish and will be rapidly compromised if continuity is not provided for by a new launcher, the development of which must be undertaken as soon as possible.

The reasons for this outlook are discussed below.

2. Long-Term Situation Regarding Ariane 4

Although it is difficult to accurately construct a mission model as of 1995-2000, certain evolutions are becoming evident as of now, making it possible to anticipate several basic trends.

a. Evolution of Geostationary Satellites

The geostationary orbit will probably remain the "commercial" orbit par excellence. Ariane can reasonably count on a market share of 10 to 15 satellites a year, most of which will not exceed 2,000 to 2,500 kg (weight in geostationary orbit). While Ariane 4 possesses the required capability, it must be remembered that its principal launch-vehicle competitor, the American Space Shuttle, will be offering a multiple low-orbit launching capability that will substantially lower launching costs per client. Hence, Ariane 4, with its capability limited to single launchings of satellites with orbital weights of 2,000 kg, or double launchings of smaller satellites, will see its competitiveness challenged again.

Added to this will be the coming increase in weight of certain satellites that are presently candidates for Ariane double launches (Telecom-PAM/D class). This weight increase is already observable and will diminish the combining potentials for Ariane-4 double launchings.

If furthermore, very heavy satellites (2,500 to 4,500 kg) make their advent toward the end of the century, they will not be launchable by Ariane 4, and this sector of the market will go to the American Space Shuttle/Centaur system.

Increasing the capacity of Ariane 4 and/or reducing its recurrent cost without fundamentally changing its configuration appear to be neither paying nor realistic approaches. Actually, the only practical possibility of upgrading its performance lies in adding a fifth Viking motor to the center of its first-stage propulsion bay, but the GTO [geostationary transfer orbital] payload gain would be only around 300 kg for the A 44 L version.

As for possible cost reductions, the sole means of achieving them would be through a significant increase in number of launches, a supposition that is contradictory to what has been said above and that presupposes a sizable modification of production and launching facilities. In any case, the most that could be expected under this hypothesis would be a launch-cost reduction

of not more than 20 percent, which would in no case equal the cost reduction per client that can be offered by a high-capacity multiple-launch vehicle like the Space Shuttle.

To the payload-weight increase must be added the volumetric increase and even more particularly the increase in usable diameter that must be offered by the launcher's nose cone. Although it appears that Ariane 4/Space Shuttle compatibility through the intermediate term will be provided by the builders of satellite platforms, this will probably not be true for the long term.

The regularization of launches by the American Space Shuttle and NASA's billing policy will unavoidably lead to the advent of standardized platforms optimized for the bay of the Space Shuttle (diameter: 4.55 meters) which Ariane 4 will be unable to launch (diameter: 3.65 meters).

Moreover, it is impossible to think of fitting Ariane 4 with a Shuttle-compatible nose cone without changing profoundly the configuration of the upper complex (2nd stage, 3rd stage and equipment bay). The present diameter of 4 meters represents a limit that it would be unreasonable to want to exceed. This diameter already poses difficult problems for Ariane 4, owing to a considerable increase in general stresses as compared to the Ariane 1 or Ariane 3 configuration.

These problems, and especially that of control, would become insurmountable with a larger-diameter nose cone.

b. Sun-Synchronous Orbital [SSO] Missions

Although an increase in the weight of earth observation satellites can be expected, it can be assumed that Ariane 4's capacity will be sufficient even for the long term (performance-rated at 5 to 6 tons). However, the possibility cannot be excluded that other SSO missions will be introduced, for which this Ariane capacity could be insufficient.

c. Low-Orbital Missions

Although no low-orbital missions of a commercial or operational nature have as yet been programmed, consideration must be given to the future, so as to be sure of having the faci;lities required to launch, on the one hand, stations or station modules (materials processing, replacement stations), and on the other hand, a service vehicle (assembly, refueling, supplies, maintenance, repairs, retrieval of spaceborne systems).

Ariane 4 is ill-suited to these types of mission:

--It is designed for a capacity of 5 to 6 tons, a capacity that is not likely to be sufficient, especially if manned flights are to be considered;

--Its cost is high in relation to its performance;

--Its reliability is not compatible with the requirements of manned flights.

Furthermore, none of the systems of this launcher is designed to ensure the safety of a crew in case of malfunction on the ground or in flight.

d. Reliability

A point the importance of which could be decisive in the long term is that of the level of reliability of launching facilities. The American Space Shuttle, which systematically transports a crew, offers, because of this, a very high probability of mission success (at least up to and including low orbit). In the long term, the users will no longer accept the level of risk involved in conventional launchers, considering the financial impact on the user in the event of a launch failure. Neither competitiveness as regards launching costs nor any policy with regard to insurance will compensate for lesser reliablity of the launching facility.

While Ariane 4's reliablity can be expected to equal that of the best conventional launchers in existence, it can never hope to equal that of a system like the Space Shuttle, which is specifically designed for manned flight.

Improvement of reliability at the design level requires a complete new approach to the basic configuration of Ariane 4 (for example, a simplification of propulsion systems and a reduction of number of stages), leading, in effect, to the new launcher it is being proposed to develop.

e. Technological Evolution

The rapid evolution of technologies, in particular in the realm of electronics, will translate into greater and greater difficulties in sustaining the fabrication of certain of Ariane 4's equipment systems and subassemblies. The disappearance of many components and raw materials is going to render future supply impossible or necessitate stockpiling involving costly purchases. A rapid evolution of techniques would entail partial modifications of the launcher that would have to be qualified, and, in certain cases, the maintaining, at high cost, of an obsolete know-how.

Beyond 1992-1994, the Ariane 4 launcher will be technologically outdated and its maintenance will, in the long run, prove more costly than the development of a new generation of launchers.

II. Principal Characteristics of the Future Launcher

The foregoing analysis shows the need for a significant evolution of European launching facilities over the next 10 years. Ariane 4 appears to be as certain to be able to respond fully to the needs of users during the period 1986-1992 as it is certain to be no longer adequate for the period that follows.

As compared to Ariane 4, a new launch vehicle must offer a certain number of improvements concerning:

1. Geostationary Missions

A significant lowering of launch costs can only be obtained through economies of scale, that is through a sizable upgrading of launching performance. This means developing the technique of multiple launching (double or triple) for small- and medium-sized satellites.

Although multiple launchings today pose significant operational problems, this will probably no longer be true in time, considering the standardized methods the American Space Shuttle will introduce (possibility of quadruple launchings).

This criterion demands an overall performance in geostationary orbit in the neighborhood of some 4,500 kg (by way of reminder, Ariane 4, in its heaviest version, can orbit a little over 2,400 kg). It is to be noted that this will be the capacity of the American Shuttle/Centaur G system (4,500 kg in geostationary orbit) and will therefore permit the new launcher to be fully competitive with the Space Shuttle.

However, single launchings of small payloads at acceptable economic rates should not be precluded. This means deriving from the future launcher a smaller-scale, lower-capacity and less costly configuration, or designing the basic configuration so that it remains competitive in the case of low fill factors.

2. Low-Orbit Missions

Besides the ability to launch platforms and orbital station modules, the new launcher will also have to be able to orbit a retrievable, possibly manned, orbital service vehicle with a payload bay capable of orbiting or retrieving payloads of 3 tons (earth observation satellites, scientific experiments, containers, etc). This objective means a performance rating of 15 tons in low orbit, a value involving the realization of a hypersonic glider capable of performing the foregoing functions.

3. Interior Volume of the Nose Cone

The nose cone will have to offer the same usable payload-bay diameter as the Space Shuttle, that is, 4.55 meters. The builders of satellites, who are presently working under the self-imposed constraint of Ariane/Shuttle compatibility will not continue doing so once they are certain of availability of the Shuttle and if this will result in a cost saving through an increase in diameter, hence in payload weight, at no additional cost.

It follows that future compatibility will have to flow from the launchers and not from the satellites.

Some projective studies on launching facilities call for nose cones of larger diameter (6 to 7 meters), but such a requirement is not foreseeable from the

standpoint of payloads, even for the long term. For the period being considered, the American Space Shuttle will probably remain the reference vehicle as regards payload girth requirements.

As for the length to be offered, that of the Shuttle's half-bay (around 9 meters) seems to be a good value, on the one hand because payloads launched into geostationary transfer orbit do not need a perigee motor as they do on the Shuttle, and on the other hand because this value appears sufficient to contain the most voluminous components of a space station. This value is compatible, moreover, with a low-orbital performance rating of 15 tons (same payload "density" as for the Shuttle).

4. Reliability

A reliability comparable to that of the Space Shuttle must be provided /even if manned missions are not anticipated/ [printed in boldface]. As has already been indicated, this point is esssential to ensure the new launcher's commercial credibility.

This means that the subassemblies of the new launcher will have to be designed, dimensioned and qualified on the basis of manned-flight criteria. To be more exact, this requirement is limited to the lower component of the launcher that is to be capable of putting a manned vehicle into low orbit. For commercial missions (and particularly for geostationary transfer missions), the overall reliability of the launcher will have to equal that of the Shuttle-plus-perigee-stage system.

Thus, from the standpoint of reliability, the question of knowing whether planning must provide for manned flight or not is pointless.

5. Safety

Safety, in the sense of crew-rescue provisions, must be ensured in case of failure of the launcher on the ground or in orbit. This function is of no value for unmanned missions. It is nevertheless advisable to incorporate the necessary safety provisions in the design of the equipment systems.

6. Growth Potential

The configuration of the future launcher must be capable of some degree of upgrading (at the price, of course, of developmental increments). In other words, as in the case of Ariane and most of the launchers in the world, the future launcher should have a growth potential.

This growth could, in time, translate into:

--An adaptation of the launcher to a mission model that is itself evolutive (payload weights, volumes, orbital services, etc);

--Use of reusable stages in the event present assumptions should change (new technologies, mission models).

Imaginable also, in time, is an evolution of geostationary launch scenarios: Payloads could be delivered into low orbit, then transferred into geostationary orbit by orbitally-based systems (tugs).

III. Research on A 5 Design

It will soon be 3 years since the CNES undertook research work on the best A 5 design based on these objectives and on the further self-imposed constraint that the development cost must not exceed 1.5 times the outlay for the development of Ariane 1.

This research was channeled along two main and distinct lines:

--Research adhering as closely as possible to the Ariane 1 and 4 approach and permitting maximized use of the know-how acquired during their related developmental programs and operational flights;

--Research on all other solutions yielding a gain of at least 20 percent on the cost per kilogram of payload launched into geostationary orbit, by comparison with the foregoing solution taken as the "reference solution." This approach gives primary importance to economic criteria during the optimization studies.

Research along this line, besides being confined to all-cryogenic designs, converged rapidly on designs capable of yielding a high rate of recovery of the first stage. Actually, aside from the fact that this stage represents almost half the cost of the launcher, it is readily evident that all second-stage weight increases stemming from its recoverability increase the complexity of the first stage and, consequently, increase the latter's cost independently of the economy achieved by recovery of the second stage.

The studies followed two parallel tracks:

--Research on a first stage yielding a rate of recovery at sea substantially higher than that of the reference solution, involving generously dimensioned structures, hence dry-propellant engines. This track led eventually to the Ariane 5 design discussed in the following paragraphs;

--Research on quasi-total recovery of the first stage, associated with a short service-resumption turnaround period.

As exhaustive an inventory as possible was made of realizable solutions (soft splashdown, glide-down return to base of departure or to a base located along the projection of the trajectory...). Analysis indicated that only one solution--a glide-down or lightly-powered return--could be considered technically promising. Such a solution, nevertheless, does not satisfy the foregoing objectives and must be considered a subsequent step, in the particular case

of a very significant increase in the numerical rate of launchings owing to sizable commercial low-orbital exploitation.

Nevertheless, this point is sufficiently important, with time, for the ESA [European Space Agency] to have launched a more detailed study for the dual purpose of developing a better knowledge of the desirable evolutions of the Ariane 5 launcher on which the final choice of its configuration should be based, and to establish a more technical dossier on the economic advantage to be derived from a glide-down recovery of the first stage, and on the technical constraints involved.

1. Ariane 5: Reference Solution

The basic idea of this configuration is to replace the second stage of Ariane 44L with a large LOX-LH2 [liquid oxygen-liquid hydrogen] stage.

These studies made it possible to:

--Show that the optimum performance obtained in the 3-stage configuration for the geosynchronous type of transfer orbit /differed very little/ [printed in boldface] from the performance obtained under conditions of injection into low orbit at the end of the second-stage propulsion cycle. Consequently, second-stage optimization studies could be conducted with the object of optimizing the 2-stage configuration for low orbit.

--Define the characteristics of the second stage based on optimized launched-second-stage cost versus performance. To this effect, cost models were developed for different quantities of propellants, hence different tank dimensions, thrust and cost of fabrication of the engine, etc. The cost of development was also taken into account. Figure 1 shows, by way of example, for a 200-km, 5-degree circular orbit, the optimum values found for the weight of propellants and engine thrust in a vacuum, depending on whether it is sought to optimize performance or recurrent cost (respectively, 78 tons of propellants and 1150 KN [kilonewtons] of thrust; 60 tons of propellants and 850 KN of thrust). Taking into account the different low-orbits considered, the final choice was 900 KN of thrust and 60 tons of propellant.

--Define the principal specifications of the LOX-LH2 engine and particularly, in addition to the level of thrust, the choice of cycle, of dimension envelope (which also determines the growth potential). The choice of shunt-flow cycle results as much from opting for a conservative approach seeking to minimize developmental contingency costs as from opting to minimize the launched-stage cost.

All together, however, these studies, effected under the self-imposed constraint of adhering to the Ariane 44 L first-stage configuration, did not yield an interesting derivation of the 4,500-kg class in geostationary-type transfer orbit. Only the addition of a fifth Viking engine in the propulsion bay of Ariane 4 can produce a family of derived launchers that would be very attractive from the cost-vs-performance standpoint.

As regards the geostationary-type transfer orbit, Figures 5 and 6 provide comparative figures on launching costs, specific costs, performance ratings, for Ariane 1, Ariane 2-3, Ariane 4 and Ariane 5 configurations. They point up especially the interest of the Ariane 50 version, which, less costly than the AR 44 L version, offers a nose-cone diameter of 4.6 meters and a payload weight around 500 kg higher.

As regards low orbit, the 54 L configuration (4 liquid-fueled positioning thrusters of the Ariane 4 type) satisfies the objective of 15 tons in low 400-km circular orbit inclined at 30 degrees, at a cost per kilogram of launched payload around 1.5 times the official Shuttle cost (1 flight at $71 million; $1 million = 5.5 francs [as published]) and around 1.05 times if one assumes amortization of an orbiter over 50 flights.

Figure 2 shows three configurations of this design, in 3-stage, no-positioning-motor, and 2-stage low-orbital versions.

2. Ariane 5 P

This design was the actual outcome of a whole series of configurations aimed at combining large, dry-propellant, high-thrust engines, well-suited for recovery at sea because of their large-dimensioned structure, for the first part of the flight, with a single cryogenic motor operating from ground level to low orbit.

Considering the experience existing in Europe with large dry-propellant engines, the assumptions made are very conservative in terms of specific thrust and of structural parameters chosen to diminish developmental contingency costs while offering the best recurrent cost.

This configuration was for a very long time handicapped by the absence of a really attractive derivation for missions of around 4,500 kg in transfer orbit, until preliminary cost studies by CNES, then by industrialists, indicated that the basic configuration could remain very competitive versus other designs, down to fill-factors of around 40 percent.

More detailed studies are in progress to better define this configuration and refine the studies on developmental and production costs, which will be the determinative factors for this configuration.

Studies on the cryogenic engine have shown that optimum thrust as a function of cost per kilogram of launched payload is very flat in the 900-1,000 KN thrust zone and that, therefore, the engine defined in the reference configuration is very adaptive.

This configuration, shown schematically in Figure 3 for GTO missions (with an H 10 stage) and for the low-orbit version, has the following characteristics:

--Cryogenic stage:

- HM60 engine, ignited at ground level
    - Thrust: At ground level: 720 KN

      In vacuum: 860 KN
    - ISP [specific thrust]: 426 sec
- 120 tons of propellants (LOX-LH2) in two separated-bottom tanks 5 meters in diameter;

--2 dry-propellant systems, segmented, recoverable by parachute,

- Dry propellant weight: Around 150 tons;
- Thrust at liftoff: 350 to 400 tons per system;
- Diameter: 3 meters.

3. Ariane 5 C (Cryogenic)

This design is the outcome of a number of configuration studies centered essentially on the use of bipropellant LOX-LH2, with possible takeoff assist to be provided by small dry-fueled thrusters developed under the Ariane 3 program.

It is shown in Figure 4:

--In a derived launcher version--4,000 kg in GTO--using the H 10 cryogenic stage as its second stage;

--In a heavy-launcher configuration--15 tons in low orbit or 7.5 tons in GTO--using a second stage powered by an HM 60 engine.

The propulsion bay of the first stage is fitted with four HM 60 engines defined above.

Studies of this configuration are still rather summary; their object has been to obtain a ballpark construction-cost figure for comparison against the foregoing configurations.

IV. Choice of Configuration - Conclusions and Remarks

The final choice of the Ariane 5 configuration will not be able to be made until the comparative technical and economic studies currently under way have been completed. Nevertheless, at this stage, two conclusions can be drawn:

--Based on an analysis of the development of Ariane 1, the total time required to deliver an operational Ariane 5, in the reference configuration or the dry-fueled heavy-propulsion version, can be put at from 7 to 8 years, starting from an engine in hand that has already yielded good results at the prototype level.

Considering the latter reservation, the targeting of operational availability by 1994 presupposes start of the program by the beginning of 1986. Taking into account the prerequisites (issue of all the rules that are to govern its management, refined planning and cost estimate studies, definition of the industrial organization, initial funding of binding commitments, preliminary requests for bids) to the actual start of this program, this objective requires a choice of configuration by mid-1984 at the latest.

--As regards the high-thrust cryogenic engine required for all the configurations studied, the actual start of its program must precede the decision relative to the launcher by at least 2 years. All the configuration studies carried out by the ESA, including an eventual configuration based on glide-down recovery of the first stage, lead to the use of the 900-KN engine originally studied for the reference solution.

This extremely important finding led the CNES to propose to the ESA the start of a 2-year engine-predevelopmental phase, beginning in early 1984.

The proposed configurations will be compared on the basis of many criteria: Cost of construction and of launching in the operational phase, developmental costs, times and possible contingencies, inherent reliabilies, ease of putting into operation, growth potential, flexibility as a function of mission model.

Considering that this new Ariane 5 launcher will have to remain operational a minimum of 20 years (barring a particularly rapid evolution of low-orbital commercial possibilities involving speeded-up launching rates), a specified weight must be assigned to cost criteria in the operational phase.

By way of example, Figures 5 and 6 situate the different designs, namely, Ariane 1, 2, 3, 4 and 5 in a cost (fabrication and launching)-vs-payload weight program for, respectively, GTO and SSO missions. The Ariane P version is also represented assuming 10 recoveries of the dry-fueled thrusters--a very conservative assumption compared with American Shuttle ambitions in this regard.

At this point in our discussion, the following remarks can be made by way of an initial and very tentative comparison of designs:

--The Ariane 5 reference design has the attraction of good continuity with the Ariane line. The decision to add a fifth Viking engine in the propulsion bay of Ariane 4 may, in this regard, appear regrettable.

Not to make this modification was to limit configurations to the 54 L (4 liquid-fueled positioning thrusters) and 54 LP (2 liquid-fueled and 2 Ariane-4 type dry-fueled thrusters), since the 54 P, 52 L and 50 configurations would be insufficiently powered at start of flight of the first stage.

True, these two 4-Viking-thrustermotor configurations offer, owing to economies of scale, a very substantial reduction in cost per kilogram of pay-

load(s) occupying their full capacity, but they are totally lacking in flexibility in the event the payload combination does not fill them to capacity.

Even aside from this consideration, reuse of the first stage of Ariane 4 without major modifications appears increasingly difficult in view of, on the one hand, the considerable increase in payload size being induced by a very--large-diameter nose cone and, on the other hand, from the propulsion standpoint, the new reliability objective.

--The Ariane 5 P design appears extremely attractive technically from the standpoint of inherent reliability, simplicity of putting into operation, and recurrent cost.

Considering the experience acquired in Europe and the extremely conservative specifications that have been drawn up as to performance ratings, the development of the dry-propellant thrusters poses no significant technical problems. Nevertheless, two points must be borne in mind:

--This configuration appears to break with the policy of successive improvements that has been diligently applied from Ariane 1 through Ariane 4;

--It does not include a derived launcher for payloads filling only a small portion of its total available capacity. The cost of the basic configuration must therefore be sufficiently attractive to maintain the competitiveness of the launcher at low fill-factors.

These two remarks underscore the vital importance of the commitments the industrialists may have to undertake regarding recurrent costs, upon completion of the feasibility studies presently in progress.

--The Ariane 5 C design has not had the benefit of as thoroughly detailed studies as did the two preceding designs, and the cost figures cited must also be viewed guardedly, the more so since they are much more sensitive to the cost variations of the future large cryogenic engine, which presents, in this regard, the greatest number of unknowns.

Furthermore, a propulsion bay for four large cryogenic engines would have to be developed, in part, concurrently with the development of the engine unit itself, would require very-large-capacity testing facilities and, as a result, would generate delays and development costs that are certain to greatly exceed those of the two preceding designs.

This very rapid overview of the status of the CNES's Ariane 5 feasibility studies has virtually considered only the "low-orbit" configuration. Actually, the problem posed by the upper section required for GTO missions, is identical in every respect for all the configurations considered.

The comparative studies undertaken recently on this point all assume maximum reuse of the H 10 stage developed under the Ariane 3 program, but will not be translated into concrete proposals prior to the second quarter of 1984.

[End of text; diagrams follow]:

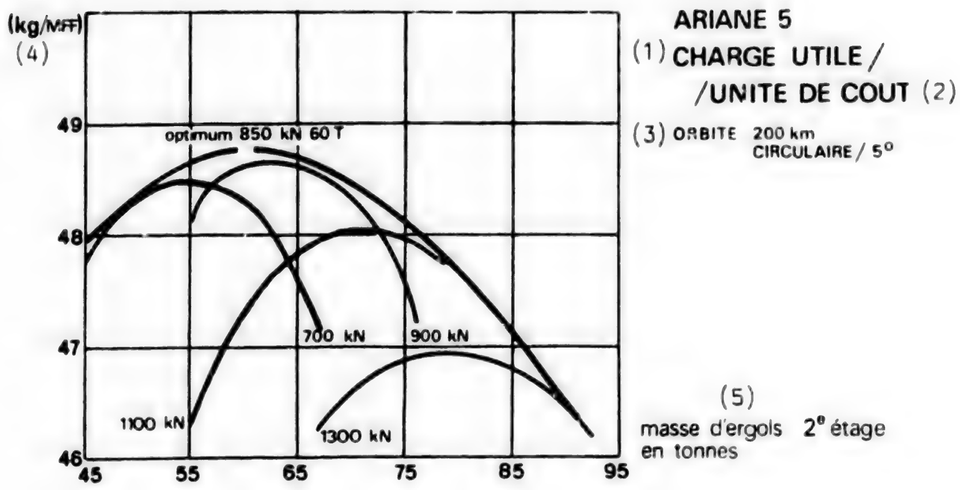

Fig. 1 (a)

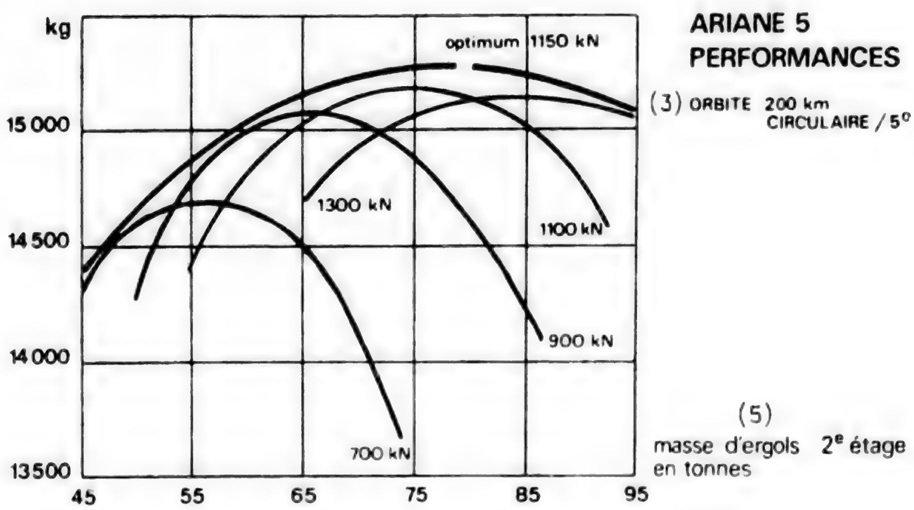

Fig. 1 (b)

Key (Figs 1a and 1b):

1. Payload.
2. Cost unit.
3. Circular orbit: 200 km at 5 degrees.
4. Kilograms per million French francs.
5. Second-stage propellant weight in tons.

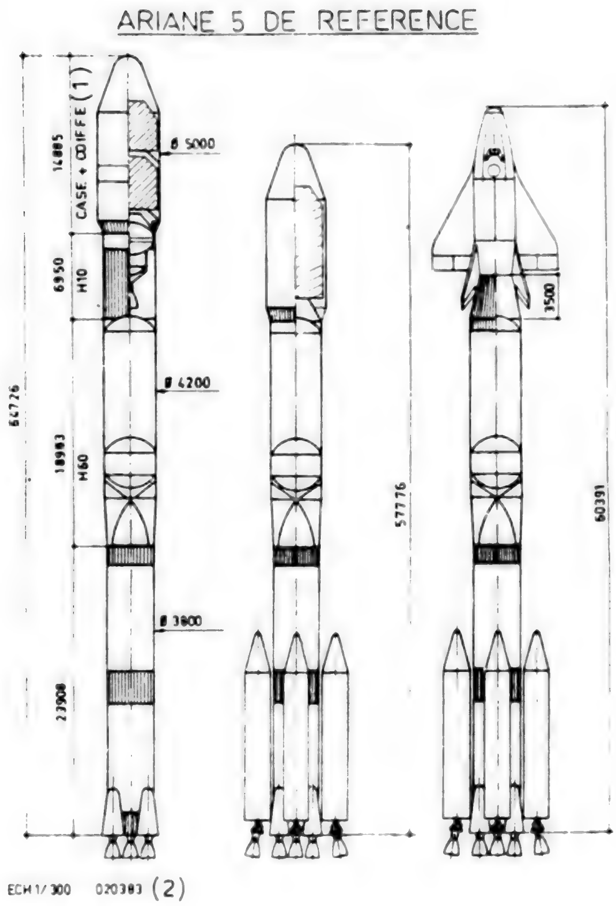

Fig 2 - Reference Ariane 5.

Key:

1. Bay and nose cone.
2. Scale: 1/300.

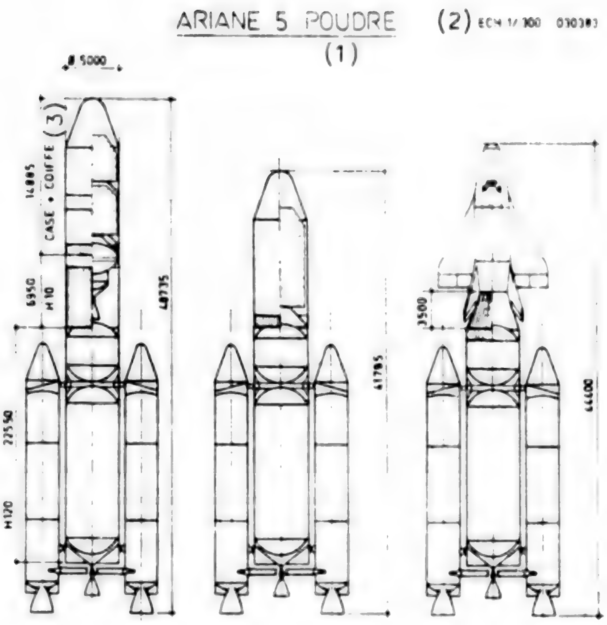

Fig 3 - Dry-propellant Ariane 5.

Key:

1. Dry propellant.
2. Scale: 1/300.
3. Bay and nose cone.

ARIANE 5 CRYOTECHNIQUE
(1)

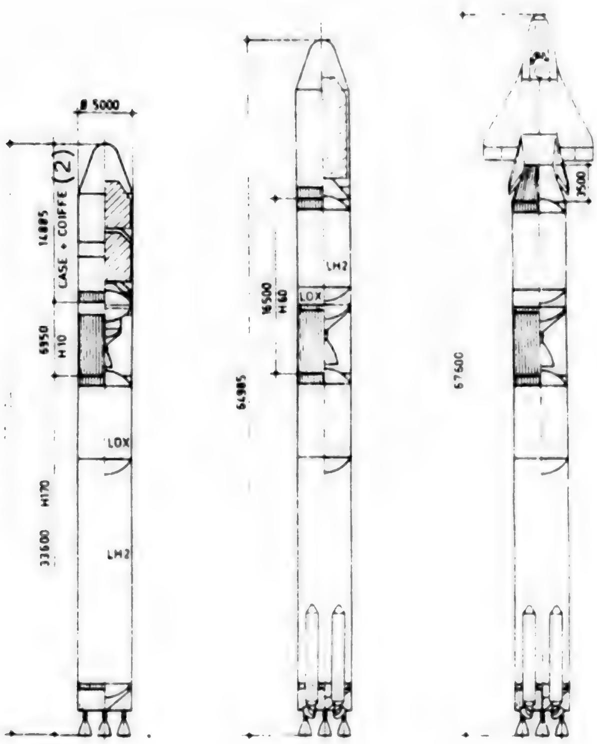

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Fig 4 - Cryogenic Ariane 5.

Key:

1. Cryogenic.
2. Bay and nose cone.
3. Scale: 1/300.

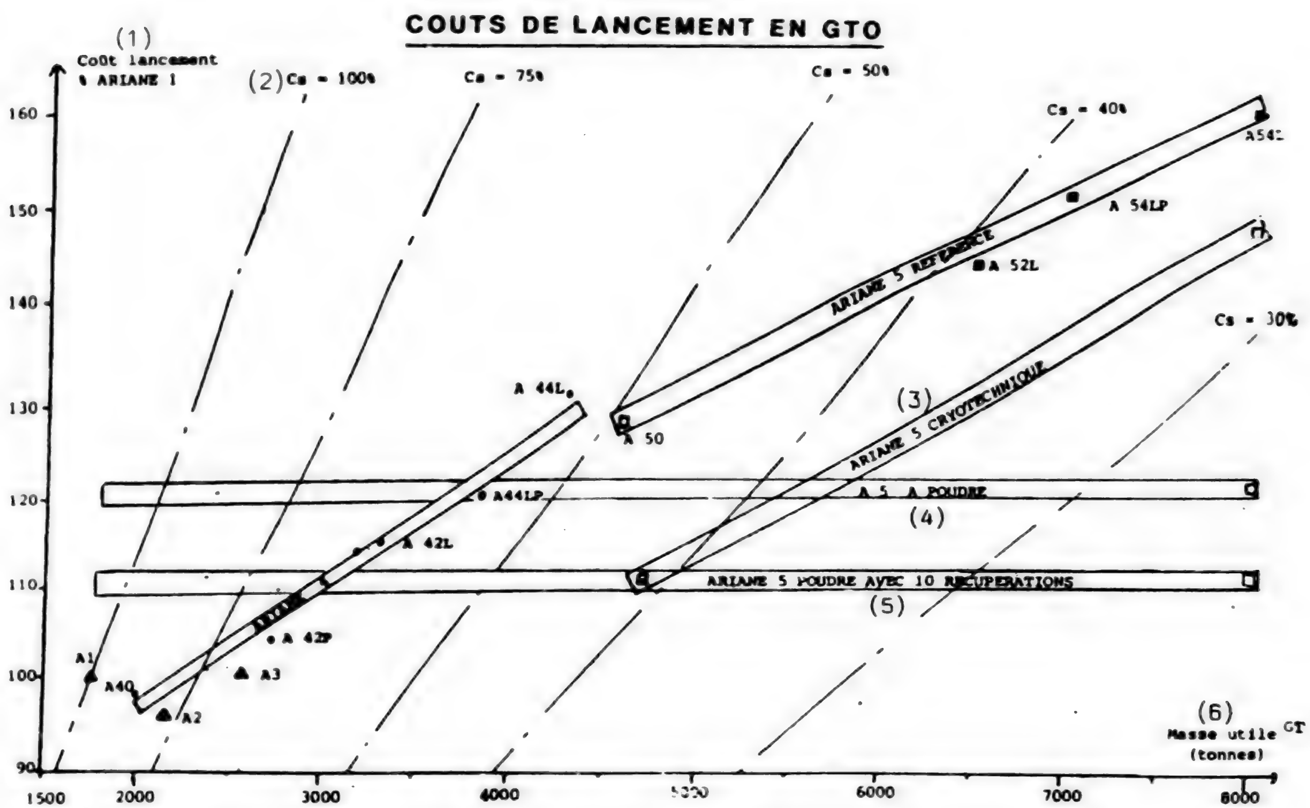

Fig 5 - GTO launching costs.

Key:

1. Launching cost.
2. Cs [specific cost] = _____ percent.
3. Cryogenic Arian2 5.
4. Dry-propellant Ariane 5.
5. Dry-propellant Ariane 5 with 10 recoveries.
6. GTO payload (tons).

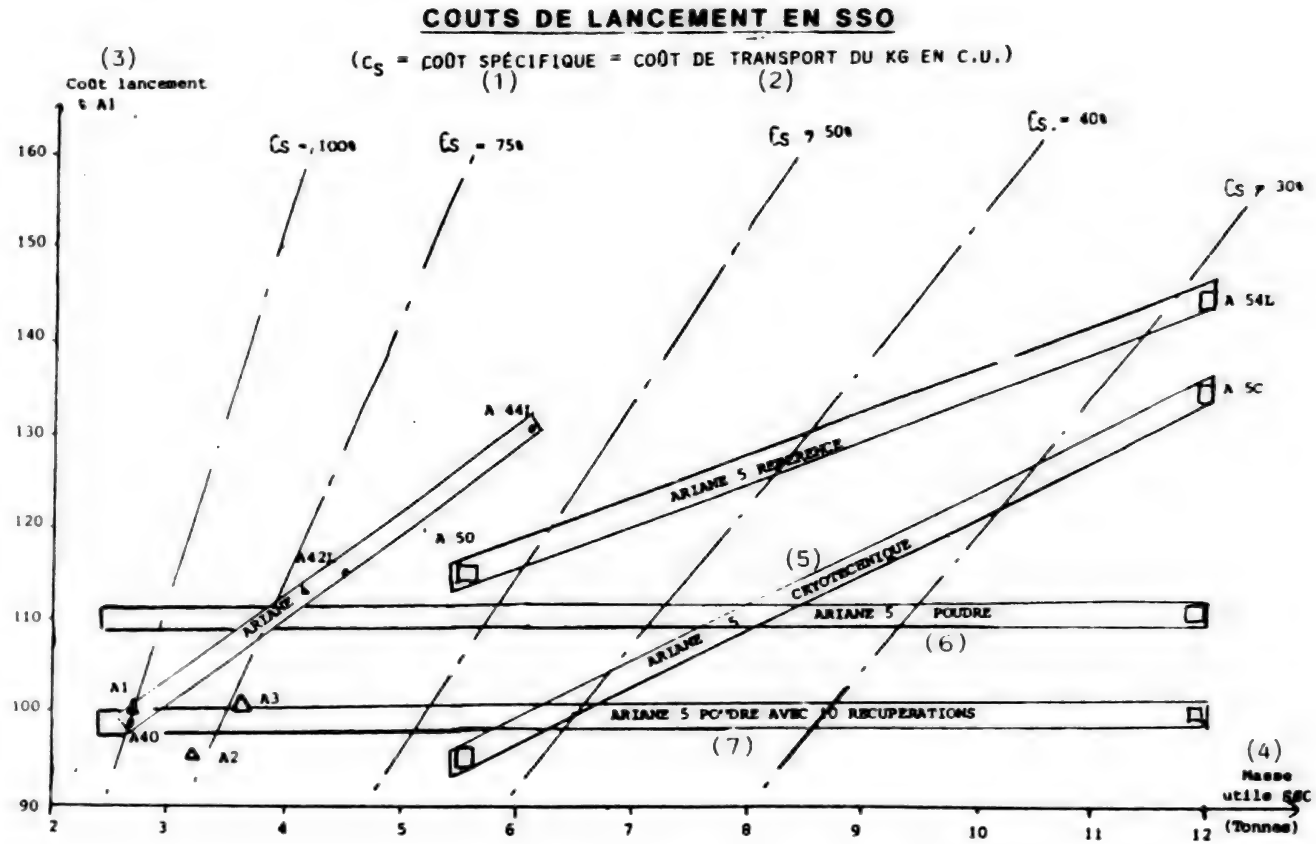

Fig 6 - SSO launching costs.

Key:

1. Cs = specific cost.
2. Transportation cost per kilogram in cost units.
3. Launching cost.
4. SSO payload (tons).
5. Cryogenic Ariane 5.
6. Dry-propellant Ariane 5.
7. Dry-propellant Ariane 5 with 10 recoveries.

9399
CSO: 3698/480

FRG FIRM DEVELOPS GERMAN-LANGUAGE SOFTWARE

Landsberg PRODUKTION in German 3 May 84 p 1

[Text] Bremen (p)--Germany has not fallen behind in all areas of information technology. In our country highly-qualified system and software firms are coming into being, which above all have one strength: To open up in general the complex electronic data processing for commercial and industrial applications. One of these enterprises in the software sector has taken a decisive step toward the simple use of the computer with a flexible electronic data processing.

If the use of microcomputers is to be worthwhile, the matter no longer ends with a universal software with whose aid the user can immediately write letters and can make calculations. However, the possibilities of the standard software quickly reach their limits when the enterprise-specific problem definitions become very complicated. Accordingly, the standard software supplied by hardware manufacturers functions sooner as a pretense to cover up the fact that application software is really not available. Up to now expensive special programs still had to be purchased or--what is even more expensive--specially produced.

Here the Gerdts Datentechnik [Gerdts Data Technology] with its Universal Programming System Gedata has made a crucial contribution. It is a German language programming system into which are simply written the tasks that are to solved:

The program asks on the screen what is to be done, makes proposals concerning how the task can be mastered, and indicates the steps. During the work it indicates at all times what is happening at the moment and what is to be done next.

With this program all tasks of data collection, data processing and data management can be solved, and in fact with a speed which surpasses traditional programming by a factor of 60. Thus a simple financial accounting system was demonstrably set up in 4 hours. Gedata is available in machine language for every marketable computer, is also hardware-independent. In the meantime, a number of solutions for particular trades have been produced, which are dis-

tinguished by the fact that they can be easily adapted to the special characteristics of enterprises and, in addition, can be expanded to any extent.

Products being supplied include trade packages for doctors, real estate agents, financing, product management, different small trade enterprises, beverage wholesale operations, schools and associations. In addition there are standard programs for warehousing, financial accounting, and text processing.

Once a user has installed Gedata, he can expand the tasks at any time. New programs do not have to be purchased. With the available software, solutions for other enterprise areas can also be written. Thus the main obstacle to the introduction of electronic data processing is eliminated: The conversion of the organization to electronic data processing. Gedata grows into the existing structure. Special training for staff members is not necessary since the user is guided in every activity by the screen. The Gedata-Universal-Programming System runs on every microcomputer.

8970
CSO: 3698/506

PHILIPS TESTS NEW MATERIALS FOR OPTICAL DATA STORAGE

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT
in German 4 Jun 84 p 7

[Unattributed article: "New Storage Materials for Optical Storage; Philips: Tellurium Selenium Compounds, Organic and Magnetic Optical Materials Are Being Tested"]

[Text] re. Frankfurt. Tellurium selenium alloys, organic compounds and magnetic optical materials are being tested in Philips research laboratories for use in optical data recording systems. Digital data (alphanumeric data and digital audio information) or video information as well can be stored depending on the material used. The advantages are fast access time and very large storage capacity. One such disk with about a 30-cm diameter can hold more than one gigabyte. According to Philips, this is equivalent to the contents of about a half-million typewriter pages in the A4 DIN format. These storage materials are embedded in an electro-optical recording disk about the size of an LP record. As Philips reports, a certain physical effect is produced by a laser upon readout as a function of the recording material used; the information contained in it is made available in coded form. The type of material also determines whether data or video information as well can be stored; this depends on the signal-to-noise ratio [SNR] achievable; because of the large number of gray values, video recording has higher requirements. The material used also governs whether or not the information can be erased.

According to the firm, Philips is testing three groups of materials: tellurium selenium alloys, organic compounds and magnetic optical material; both of latter groups are almost entirely still in the research stage. Despite the large difference between the new materials for optical information recording, there is some characteristic correspondence in the recording and playback system. Irrespective of which disk type is used, the system is optimized for use of a diode laser which emits in the infrared range with a wavelength of about 800 nanometers, Philips reported. This laser causes a physical effect in the storage material: This can, for example, be the formation of a small hole or a change in the aggregate state in a tellurium selenium alloy. Other physical effects concern the formation of a pit in an organic compound as well as the formation of a domain with another magnetization agent in a magnetic optical material. According to Philips, all areas hit by the laser light have a diameter of about one micrometer. The laser power used to record information is about 10 milliwatts with a pulse length of 50 nanoseconds. Readout power for all materials is about 0.5 milliwatt.

One of the new materials for information storage is a polycrystalline tellurium selenium alloy which contains small amounts of other elements such as, for example, arsenic for better control of the melting point and stability of the material. A thin coat of this alloy is, according to Philips, deposited on a substrate. By using a small laser beam, this material can be melted in spots so that holes as deep as the thickness of the coat are produced. When the coating is read by a less intensive laser beam, the presence or absence of holes is distinguished in the reflection of the laser light. This reflection difference reproduces the information in coded form.

Philips says the proper alloy composition and the technique for depositing the alloy in a very thin coat on a disk are very important. Disk durability has to be exceptionally high, the firm says. Based on tests for duration, retention of stored information is guaranteed for at least 10 years with no special requirements for the environment. Storage in a climatized room increases durability considerably. The SNR achievable makes the tellurium selenium alloy also suitable for video recording.

By using tellurium alloys, information can also be written and erased on a disk, and the disk can be reused. By adjusting the laser output power, the polycrystalline material is indeed melted, but no pits reaching the substrate are formed. After the laser pulse ends, the melted areas cool so fast that they freeze in a metastable amorphous phase. During readout, the reflection from these amorphous domains is different from the crystalline environment. During erasure, the amorphous areas are returned to the crystalline phase by using a laser of sufficiently high output power. It has been demonstrated that erasures can be made often enough for most applications.

Philips is also testing organic compounds: The firm says that there are organic compounds which absorb much light even in very thin coats and have a large reflection capability. These thin coats appear to be a very promising alternative to tellurium selenium alloys. The storage effect is achieved by a laser which melts the material in spots so that small pits are produced in it. The difference from a tellurium selenium alloy is that these pits do not reach the substrate. The reflection varies with pit depth. The reflection difference produced by the pit pattern is used for information readout. This melting process is not reversible, though; the disk can thus be written on only once and forms thereby a ROM (read only memory) unit. Philips reports with respect to durability that the information has been shown to be as stable as with tellurium selenium alloys. The question of resistance to light as well as to heat and humidity has played a special role here in the process. The SNR is high enough here too for video information.

Among the other recording systems under study at Philips are gadolinium iron cobalt compounds. By using a laser to heat this material, the magnetic polarity of small areas can be reversed and this state "frozen." This technique offers the capability of "writing on" a magnetized coat with a pattern of small areas with opposite magnetized directions. This pattern can be readout with polarized laser light. Because of the Kerr effect, the polarization direction of the reflected light with respect to that of the incident light is rotated somewhat. The direction of rotation depends on the magnetic direction, Philips reports. The information code pattern can be obtained from that. Reversing it produces erasure. According to current discoveries, the recording of digital data is possible; improving the SNR enough to record video signals has, however, not been ruled out.

8545
CSO: 3698/507

FRG FIRM SHOWS FLEXIBLE MANUFACTURING CELL FOR COG WHEELS

Bern TECHNISCHE RUNSCHAU in German 22 May 84 p 25

[Text] At the Metav in Düsseldorf, automatic and flexible cog wheel production will be shown on a flexible production cell that is built-up exclusively of interlinked flexible standard machines. According to the manufacturer's specifications, the unit costs here are about 40 percent lower than with conventional production.

To an increasing extent, machine tool users require complete problem solutions including economic considerations. The machine tools from various manufacturers must here frequently be linked. An outstanding example of this was exhibited at the Metav in Düsseldorf by the four manufacturers Emag, Pfauter, Höfler, and Lenze, on their VDMA stand. Here, medium enterprises have seized the initiative and have presented a pioneering design, the flexible production cell for cog wheels (Figure 1). During the Fair, two different work pieces were produced here.

Economy is the first question

Generally speaking, large unit numbers are presupposed for the economical use of flexible production cells. Nevertheless, very small lot sizes can also be produced efficiently, a feature which even applies with a constant change of work pieces, that is with a lot size of one. This was shown at the Metav with a flexible production cell.

As regards economy considerations, the flexible production cell for cog wheels is compared with a conventional, non-automated production and respectively also with a rigidly linked production line for the same work pieces. For the flexible system with linked standard machines, the investment costs were here about 60 percent higher. This led to an increase of fr. 60.00 in the total hourly rate. With the flexible production cell, however, the unit costs could be reduced by about 40 percent as compared to the non-automated conventional production, and even more for small lot sizes. Because of the flexible production, the personnel can be reduced from four operators to one operator. Thus, the total hourly rate in the present case could be reduced from fr. 250.00 per hour with non-automated production to fr. 218.00 per hour with the flexible production cell.

The work piece replacement times as a whole were reduced in the flexible production cell due to automated loading and unloading. In the case of the cog wheel machine, for example, to about one third.

There are also further advantages, which are not primarily reflected in this economy consideration:

- No intermediate transport and no intermediate storage of the work pieces between the individual production units.

- Higher capacity of the flexible production cell through shorter production times; thus a smaller number of machines is needed.

- Production during breaks without and in all shifts with only one system operator.

- A lower organizational breakdown rate, fewer sequence-based idle times, and no output reduction through personnel distribution times.

- One hundred percent quality control of individual operations with automatic feedback and appropriate corrections.

- Reduction of material circulation by adapting the lot sizes to the actual need (especially important in comparison with a rigidly linked production line which must be converted with a great deal of effort).

The most modern engineering is just barely good enough

The flexible production cell for cog wheels, which was shown at the Metav, offers modern engineering, where the machine tool and the linkage can be converted rapidly. The work pieces are recognized according to type, position, and processing state. The raw parts are fed in unordered (Figure 2) and are stored ordered in pallettes (Figure 3). The correct functional dimensions are called in automatically. The flexible production cell for cog wheels pursues a clear design: The machines are operated from the front, the work pieces are conveyed from the top, and the machines are emptied towards the rear.

The production cell essentially consists of a CNC two-spindle automatic lathe MSC 12 with an automatic loader and an integrated work piece measuring station (Figure 4), a CNC hobbing machine PE 150 AW (Figure 5), an automatic double-plank gear rolling fixture (Figure 6) as well as a multi-spindle deburring machine, the Gratomat MS 150, with six stations. The manufacturer of the lathe also supplied the mechanism for feeding in the raw parts together with storage, magnetic conveyor, work piece recognition and turning apparatus, linkage, portal loader, as well as the palletting stations.

The working sequence begins with the separation and recognition of the raw forging parts. After the work pieces are turned on the CNC double-spindle unit, the boring is measured automatically and the measured value is used for automatic tool correction. The turned part that has been checked is placed on the receiving station of the magazine of the CNC hobbing machine. This operation is performed by a placing unit.

After hobbing, the double-flank measuring station automatically measures each cog wheel. Here, a computer, memory, and evaluation unit are connected with the control of the hobbing machine. Thereupon, the parts are cleaned in a washing machine and are dried. The upper and lower side of the cog wheels are deburred on the six-station special deburring machine (Figure 7). Then they are chamfered and brushed.

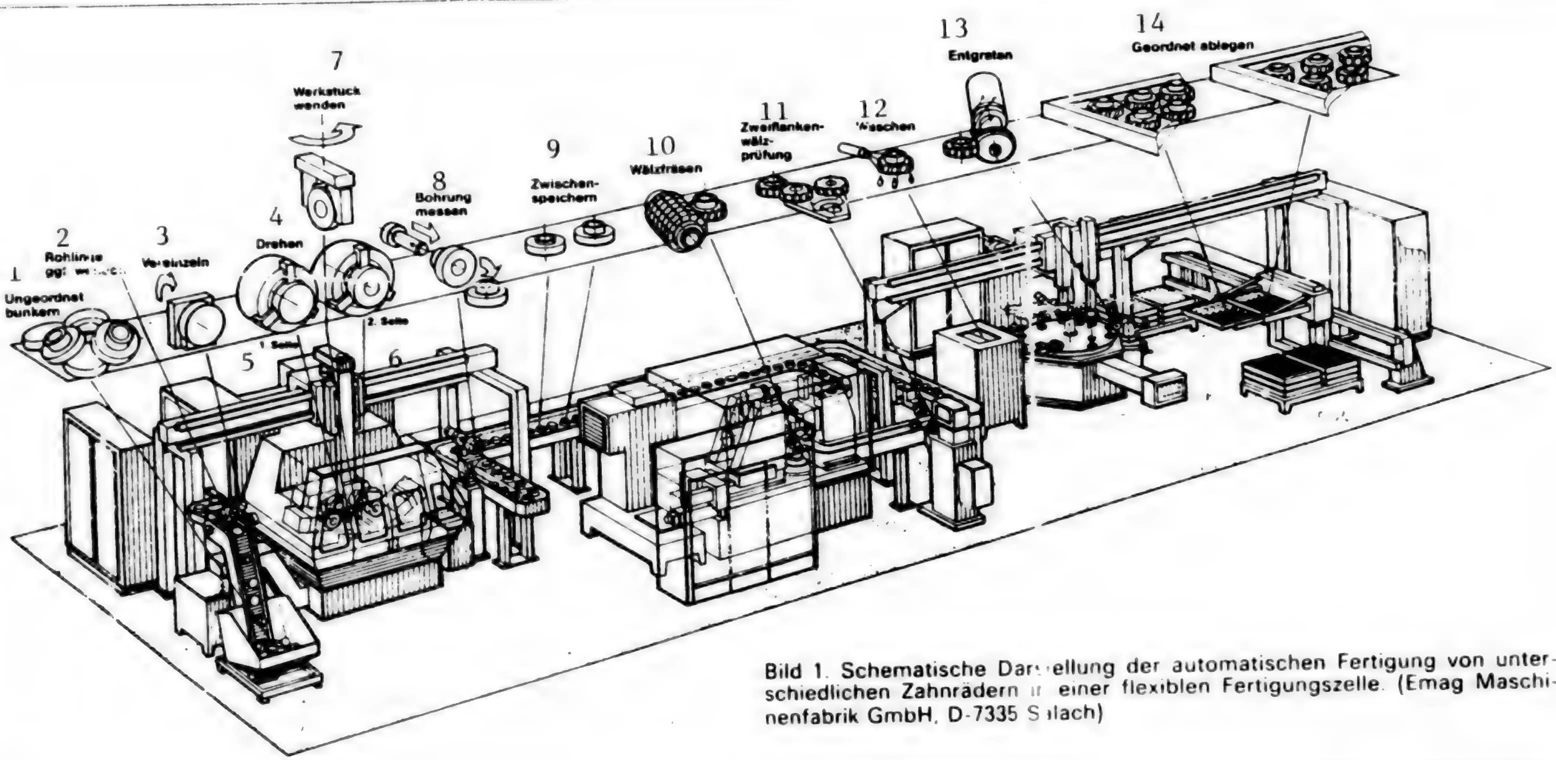

Bild 1. Schematische Darstellung der automatischen Fertigung von unterschiedlichen Zahnrädern in einer flexiblen Fertigungszelle. (Emag Maschinenfabrik GmbH, D-7335 Salach)

Then the finished cog wheels are separated according to construction type and are placed in the ready pallettes. When the pallettes are full, they are automatically stacked to form a tower.

Figure Captions:

Figure 1 Schematic representation of the automatic production of different types of gear wheels in one flexible production cell. (Emag Machine Factory GmbH, D-7335 Salach)

1	unordered storage	8	measure boring
2	raw parts turned if necessary	9	intermediate storage
3	separation	10	hobbing
4	turning	11	double flank gear-rolling machine
5	first side	12	washing
6	second side	13	deburring
7	turned work piece	14	deposit in ordered fashion

Figure 2. Supply of raw parts from the bulk-goods container, magnetic conveyor, and work piece recognition and turning apparatus (Emag Machine Factory GmbH, D-7335 Salach).

Figure 3. Pallettizing station for finished cog wheels. The full pallettes are stacked to form a tower. (Emag Machine Factory GmbH, D-7335 Salach).

Figure 4. CNC double-spindle lathe MSC 12, as the first processing machine in the flexible production cell (Emag Machine Factory GmbH, D-7335 Salach).

Figure 5. CNC hobbing machine equipped for the processing of two different types of teeth (Hermann Pfauter GmbH & Co., D-7140 Ludwigsburg).

Figure 6. Automatic double-flank gear rolling fixture with attached computers as memory and evaluation unit. (Dr. Eng. Höfler Measuring Instrument Construction GmbH, D-7505 Ettlingen).

Figure 7. Six-spindle special deburring machine, Gratomat MS 150/6, here equipped for the deburring, chamfering and brushing of two types of gear wheels. (Hans Lenze GmbH & Co., D-3251).

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FACTORY AUTOMATION

FRG'S 'INPRO' PROMOTES ADVANCES IN AUTO PRODUCTION TECHNOLOGY

Duesseldorf HANDELSBLATT in German 29 May 84 p 15

[Article: "INPRO/Berlin Innovation Company to Assume Promotional Function in Research. Emphasis on Robots and Automation"]

[Text] as Berlin--The function of INPRO [Innovation Company for Advanced Production Systems in the Motor Vehicle Industry GmbH, Berlin], is to promote and intensify research activity, according to Dr Guenter Spur, technical director of INPRO, who spoke on the occasion of the company's introduction.

INPRO was founded just under a year ago to promote the quickest possible industrial application of new technologies in order to keep pace with increasingly stiff international competition. The company was co-founded by Bayerische Motorenwerke AG (BMW), Daimler Benz AG, Volkswagenwerk AG, Siemens AG and the Berlin Senate, all of which hold equal shares of the DM 2 million nominal capital. The company currently employs a staff of 18, of which 13 are active in the scientific and technical fields.

INPRO's budget for the current year is approximately DM 5 million, an amount which will increase over the next several years in accordance with the trend in joint or individual orders received by INPRO from its shareholders or orders from third-party customers.

INPRO will initially work on four overlapping projects which in general will deal with automation in industrial production. These projects will specifically concern intelligent sensor systems, programming systems for industrial robots, techniques of simulation and expert systems. These initial, entirely computer-oriented projects as well as their selection strongly underscore the interrelationship between information and production technologies, said Dr Spur.

Dr Spur added that the purpose of the company--to promote the application of innovative developments in the field of production technology rather than product technology--is evident from its name. He said INPRO's tasks include observation and analysis of worldwide research and development projects, observation of market trends, acceleration of technology transfer, coordination of research projects and training of qualified personnel with the objective of increasing the level of productivity and quality in the shareholder companies.

The Berlin Senator for the Economy Elmar Pieroth noted that INPRO's inception was a result of the economic conference held in December 1982. INPRO, the Berlin Innovation and Founders' Center (BIC) and numerous other activities are proof of the fact that the initial effect of this conference was to catalyze such efforts, he said, and added that he intends to play a major role in the promotion of joint ventures such as INPRO. Three additional interesting projects are to be introduced at the next economic conference scheduled for 20 June.

12644
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FRG GOVERNMENT REPORT ON 1983 RESEARCH POLICY, SPENDING

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German
1 Jun 84 p 7

[Article by Christian Lenzer, member of the Bundestag: "The FRG Spent About DM 46.8 Billion for Research. Inventory of Research Activities in 1983"]

[Text] Bonn. In its new Federal Research Report VII, the Federal Government presents a comprehensive report on the research policy of the Federal Government and an inventory of German research activities. The most important particulars from this research report:

1. Research expenditures in the FRG. If one takes the research expenditures as a measure of the activities of a country in the sphere of research, then the FRG in 1983 spent 2.6 percent of its gross national product for research, this amounts to DM 46.8 billion. Two-thirds of the German research expenditures are carried out in the German economy. The DM 31.6 billion in research expenditures in 1983 are self-financed to the extent of 82 percent. Approximately 370,000 persons (calculated in terms of full time) are employed in the FRG in research, of these two-thirds in the sphere of the economy.

The research in the universities and in research institutions outside the universities and the granting of research funds abroad are predominantly financed by the state itself. In particular the Federal Government is making a decisive contribution here with its 12 billion in research expenditures. The expenditures of the Federal Government and the lands for research came to almost DM 20 billion in 1983. The research report of the Federal Government depicts in detail how these funds were used. At the center of the research report is the guidance of research and development [R&D] in the state sphere through research funds. The exertion of influence on research through laws and regulations, i. e., through the change of demand, is not the main emphasis. If one therefore focuses on the expenditures of the Federal Government for research to enterprises of trade and industry, the result is the development as shown by Table 1.

From this one can note the following on the basis of the year 1983: The grants of the Federal Government for research expenditures amounted to about 17 percent of the total expenditures of the economy for R & D, or DM 5.4 billion. The expenditures for defense research are DM 1.5 billion, for research in the civilian sector DM 3.9 billion. More than 25 percent of the research

Table 1. R&D Expenditures of the Federal Government to Enterprises of Trade and Industry, Including Tax Relief[1]

Expenditures	1979 Millions DM	1982 Millions DM	1983[2] Millions DM
R&D expenditures, including tax relief, total	4,609	5,771	5,414
Including:			
Expenditures of the Federal Ministry of Defense (defense research)	1,548	1,336	1,468
Civilian R&D expenditures, total	3,061	4,435	3,946
Of these:			
Tax relief[1]	169	283	510
Indirect subsidy programs	313	418	386
Indirect specific promotion	--	89	150
Direct promotion	2,579	3,645	2,900
Of these:			
High temperature reactors and fast sodium reactors development	330	1,027	765
Civilian R&D expenditures without tax relief 2892 [as published]	4,152	3,436	
Including:			
R&D expenditures for small and medium-size enterprises (in %)	21.2	19.8	24.7

1) § 4 InvZulG [Investment Subsidy Law] and § 51 EStG [Income Tax Law] (R&D Special Depreciation Allowance)
2) Estimated
3) Development of the reactor lines

outlays of the Federal Government to enterprises of trade and industry are accounted for by indirect forms of relief, such as tax relief and different variants of allowances. The direct promotion of projects still predominates in the case of the support for civilian research, but it is strongly influenced by large-scale projects. The project support for high temperature reactors and fast breeders cost DM 765 million in 1983. An investigation of the structure of the research promotion by the Federal Government by small and medium-size enterprises shows that 25 percent of the research expenditures of the Federal Government for civilian research outlays fall to the share of smaller and medium-size enterprises (KMU). The percentage increases to 48 percent if one excludes large-scale technological projects, in the

case of which large enterprises statistically appear as initial recipients of the funds.

The figures for the project support in the economy are relativized if one takes into consideration that the allowances are concentrated on large technological development lines. For example, in 1983 the following large technological development lines were supported by the Federal Government:

Table 2. Large Technological Projects Supported by the Federal Government in 1983

Project	DM Millions
Development of fast breeder reactors	520.7
Development of high temperature reactors	522.9
Ball-bearing technology	284.2
Magnetic trajectory	138.2
TV-satellite	15.0
Space laboratory	56.5
Airbus	177.3
Defense sphere (MRCA [Multi-purpose combat aircraft])	450.0

Clearly a structural change has taken place in the last few years in connection with the research support of the economy by the Federal Government, a change which expresses itself as follows: Concentration of direct project promotion in the economy on basic technologies. A reduction of 20 percent in the case of directly-supported projects in the economy results from this, for example, in the Federal Ministry for Research and Development, as well as a strong increase of indirect research promotion through tax relief measures and various allowances.

2. Functions of the state: It has already been pointed out that the Federal Government and the lands have the decisive task to help finance the different state research institutions--from the universities to the institutions outside the university. In so doing, the task of the lands naturally lies in supporting the universities, while the institutions outside the universities are not as important. In the case of the Federal Government, with its DM 12 billion, the expenditures by recipients are distributed as follows:

Table 3. Distribution of Federal Research Expenditures in 1983

Recipients	In %
Federally-owned institutions	10.4
Institutions of the lands and communities, including universities	8.1
Scientific organizations	29.9
Society, enterprises of the economy	43.9
Foreign countries	7.7

Within the Federal Government the Ministry for Research and Technology is of decisive significance because it controls approximately 70 percent of the civilian research expenditures of the Federal Government. If one considers the research expenditures of the Federal Government in terms of the support emphases, the following points of main effort emerge from the example of the year 1983 (depicted in terms of the outlays for the individual areas):

Table 4. Federal Research Expenditures in 1983, by Area

Item	DM Millions
Overall expenditures	12,054
Energy research and energy technology	2,492
Max-Planck-Gesellschaft [Max-Planck-Society], Deutsche Forschungsgemeinschaft [German Research Association], and other scientific institutions	13,750
Defense research and technology	18,058
Basic scientific research	746
Rationalization of technical and scientific department services	819
Research on the polar regions, ocean research, ocean technology	183
Space research, space technology	762
Raw material securing, water research, material research	425
Ground transportation and communication	293
Aviation research	355
Information technology	520
Biotechnology	99.1
Physical technologies	92
Manufacturing technology	38.5
Environmental research, climate research	276
Health research	479
Nutrition sphere	249
Humanization of the work sphere	144
Education and professional training research	142
Vocational information	68
Arts and social sciences	281
Manufacturing technology	38.5

The main points of effort of the research expenditures of the Federal Government are found in energy research, defense research, and the promotion of institutions of basic research. For these three spheres, 48 percent of the research expenditures of the Federal Government are transacted. This structure of the research expenditures is also related to the special objectives of the Federal Government within the research system of the FRG. From the expenditures of the Federal Government for non-nuclear energy research, for example, one can in no way conclude which points of main effort with respect to non-nuclear energy research are being worked on within the FRG. Since the expenditures of the Federal Government are concentrated only on a part of the German research expenditures, no statements can be made from the priority definition of the federal expenditures with respect to the main emphases for

the economy as a whole. And it is the indicated distribution according to emphases which results from the special objectives of the state, viz., to finance long-term research projects. In the research report of the Federal Government, detailed information is provided about all of these areas. The individual scientific organizations are described systematically.

Research policy: In the Research Report VII of the Federal Government, part I is concerned with the orientation of research policy, in particular with the new direction of research policy since the takeover of the Federal Government by the CDU/CSU and FDP. After a description of the significance of research and technology, the fundamental features of the new policy are sketched. In key words it can be described as follows:

--Acknowledgment of freedom of research, in particular of state-promoted basic research;

--improvement of self-initiative and improvement of the outline conditions for science and research;

--within the meaning of the principle of subsidiary character as much as possible reserve on the part of the state vis-a-vis research and development of the economy, especially in the case of standards with respect to the content. Use of public funds as a matter of principle only where the state has responsibilities of its own or where the forces of the market economy alone are not sufficient. The creation of a friendly climate, especially favorable and reliable outline conditions for research and development and innovation. Creation of a framework of regulations, in which private initiative and entrepreneurial self-responsibility develop;

--affirmation of technical progress as the foundation for international competitive strength, economic growth, employment;

--recognition of performance and challenge of peak performances across the entire spectrum of research and development.

In particular a view is expressed on the most diverse aspects of research policy in the political part (78 pages of Size A-4). By way of summary we can note that the Research Report VII clearly sets forth the research policy perspectives of the Federal Government for the next few years and is also a general information and reference work for every interested person who wants to inform himself about the promotion of research and development in the FRG.

8970
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FRG R&D STRUCTURE, FUNDING, INTERNATIONAL COMPARISONS

Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 7 Jun 84 p 3

[Article entitled: "More Research Is Being Done. Battelle: The Growth Gap, However, Is Not Yet Being Closed"]

> [Text] In the current year, probably more than DM 50 billion will be spent in the FRG for research and development [R&D]. This is the conclusion of a study by the Battelle Institute in Frankfurt. In so doing, the FRG finds itself in international competition, which, in the view of Battelle, is an important motive for the increase of the research efforts. But in considering the research outlays it must not be concluded that every mark invested there will produce a certain measure of research results. Other important factors are the quality of the researchers, the tasks that have been set, and the starting position from which the search for something new is undertaken. Research remains a difficult and risky enterprise.
>
> The Editors

The research budget of the FRG will increase nominally by close to 6 percent to over DM 50 billion in 1984, according to a Battelle study. The research sphere thus has DM 2.75 billion more at its disposal than in the previous year. Given an expected price increase of 3 percent, the real increase will be about 3 percent. After 4 lean years, it will be possible to again find the gradual connection to the more rapid international development. However, further efforts are necessary, as well as a still greater dynamic if the growth gap in the international comparison is to be closed once again.

With this research budget, measured by the social product, the FRG continues to be among the leading research nations. However, since the United States and Japan had substantially higher rates during the past few years, the distance to these nations has increased. The United States has expanded its research budget year after year by about 4 percent in real terms during the past 5 years, with the American Federal Government and the economy participating approximately equally. For the year 1984 a real increase of 3.7 percent is expected. The share of the research expenditures in the social product, which since the beginning of the 1970's registered a declining trend, thus once again increased and at the present time--according to American apportionment--again stands at 2.6 percent.

Table 1. Research Budget[1] [of Selected Nations, 1975-1983]

Nations	Researcher 1979 in 1000	1975 Nominal Million $	1979 Nominal Million $	1983	%	1975 Real Million $	1979 Real Million $	1983	%	75/79 Increase Real %	79/83 Increase Real %
FRG	122.0	9,760	14,740	19,120	35.2	9,760	11,965	12,750	47.7	5.2	1.6
Great Britain	103.0	3,670	7,160	14,150	26.1	3,670	4,300	5,440	20.4	4.0	6.1
France	72.9	3,850	6,480	11,900	21.9	3,850	4,170	4,630	17.3	2.0	2.7
Italy	46.4	865	1,690	4,360	8.0	865	885	1,180	4.4	0.6	7.5
Netherlands	18.3	1,685	2,230	2,710	5.0	1,685	1,675	1,700	6.4	-0.1	0.4
Belgium/Luxembourg	11.0	660	975	1,240	2.3	660	675	670	2.5	0.6	-0.2
Denmark	6.0	280	400	570	1.1	280	280	285	1.1	0.0	0.4
Ireland	2.6	35	80	140	0.3	35	45	45	0.2	6.5	0.0
Greece	2.6	--	45	90	0.2	--	25	25	0.1	--	0.0
European 10	384.8	20,805	33,800	54,280	100.0	20,805	24,020	26,725	100.0	3.7	2.7
USA	621.0	35,213	54,972	86,500		35,213	41,300	48,950		4.1	4.3
Japan	281.9	10,540	16,335	26,930		10,540	12,760	16,600		4.9	6.8

1) Domestic execution = GERD [not further identified]

During the past 5 years, Japan has increased its research budget nominally by 2-digit rates per year. The real increases in the individual years ranged between 6 and 8 percent. These considerably high rates of increment led to a steep increase of the research expenditures as a percentage of the social product. The magnitude today stands at 2.6 percent. In so doing, Japan is at about the same level as the FRG and the United States. If this dynamic continues, the 3 percent mark will be reached in a few years. This is the declared goal of the Japanese.

Who finances research? The research budget of the FRG is financed in the main by the state and by the economy. As a result of the low rates of increment, the state share has been declining for years and at the present time stands at about 39 percent (1979: 43 percent). During the same period of time, the financing share of the economy has continuously increased. We expect that in 1984 approximately 59 percent of the means will have to be generated by the economy (1979: 54 percent).

The research expenditures of the Federal Government this year come to about DM 12.3 billion. About 40 percent of these funds are locked up through the institutional promotion of research institutions, about 6 percent go abroad within the framework of international cooperation. For the direct and indirect promotion of projects, 55 percent of the funds are available. The indirect promotion is gaining increasingly in significance. Approximately 90 percent of the research funds are concentrated in 4 spheres:

Table 2. Main Spheres of Research Support in the FRG

Sphere	In %
Research and technology	57
Defense	15
Economy	10
Education and science	8

The research tasks of the federal lands go predominantly to university research. A part is locked up through the institutional promotion of research institutions. A growing part is going to small and medium-size enterprises of the economy within the framework of application-oriented technology promotion programs of the lands. In 1984 an amount of slightly over DM 7 billion will be available, this is approximately DM 100 million more than in the preceding year. The financing share of the research budget stands at close to 14 percent.

According to our estimation, the economy will make available close to DM 30 billion of its own means for research and development work. The financing share of the economy, which since the mid-1970's has been continually increasing, thus amounts to 59 percent in round figures. The nominal increase stands at 8.7 percent. Consciousness of research has clearly increased recently in many enterprises. The recognition that the competition in national and international markets is largely carried out as technology competition is becoming widespread, so that an increased use of new technologies can be expected. The

Table 3. Gross Domestic Product [GDP] and Research Budget: FRG, United States and Japan, 1962-84

	Germany				United States				Japan			
Year	GDP Billion DM	R&D Million DM	R&D Share %	R&D Increase %	GDP Billion $	R&D Million $	R&D Share %	R&D Increase %	GDP Billion Yen	R&D Million Yen	R&D Share %	R&D Increase %
1962	360.9	4,300	1.2		569.1	15,394	2,7					
64	422.1	6,170	1.5		642.8	18,854	2.9					
66	492.1	8,370	1.7		762.7	21,846	2.9					
68	540.5	10,000	1.9		863.0	24,605	2.9					
70	678.8	14,090	2.1		981.2	26,134	2.7					
1971	754.9	17,210	2.3	22.1	1,061.1	26,676	2.5	2.1	81,569.0	1,345.9	1.7	12.6
72	826.0	18,570	2.2	7.9	1,168.3	28,477	2.4	6.8	92,748.0	1,586.7	1.7	17.9
73	918.6	19,810	2.2	6.7	1,302.1	30,718	2.4	7.9	113,069.0	1,980.9	1.8	24.8
74	987.1	21,560	2.2	8.8	1,406.8	32,864	2.3	7.0	135,312.0	2,421.4	1.8	22.2
75	1,034.0	23,710	2.3	10.0	1,538.6	35,213	2.3	7.1	148,031.0	2,621.8	1.8	8.3
76	1,22.8	24,820	2.2	4.7	1,705.7	39,016	2.3	10.8	165,851.0	2,941.4	1.8	12.2
77	1,200.5	26,840	2.2	8.1	1,902.4	42,829	2.3	9.8	184,460.0	3,233.5	1.8	9.9
78	1,286.4	30,740	2.4	14.5	2,131.8	48,184	2.3	12.5	202,638.0	3,570.0	1.8	10.4
1979	1,392.5	35,805	2.6	16.5	2,383.2	54,972	2.3	14.1	218,616.0	4,063.6	1.9	13.8
80	1,481.4	38,845	2.6	8.5	2,594.0	62,734	2.4	14.1	234,949.0	4,683.8	2.0	15.3
81	1,542.6	41,405	2.7	6.6	2,906.3	72,118	2.5	15.0	249,101.0	5,246.3	2.1	12.0
82	1,599.1	44,390	2.8	7.2	3,030.0	79,000	2.6	9.5	261,700.0	5,982.0	2.3	14.0
83	1,666.0	46,450	2.8	4.6	3,277.0	86,500	2.6	9.5	274,260.0	6,700.0	2.4	12.0
84	1,765.0	49,200	2.8	5.9	3,596.0	94,200	2.6	8.9	290,700.0	7,500.0	2.6	12.0

Table 4. Development of the Research Budget--Federal Republic of Germany, 1979-1984

Financing Sphere	1979	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984
Federal government	9,845	10,400	10,700	11,890	12,050	12,300	5.6	2.9	11.1	1.3	2.1
Lands	5,920	6,430	6,900	6,900	6,950	7,050	8.6	7.3	0.0	0.7	1.4
Communities	175	170	150	150	150	150	--	--	--	--	--
State	15,940	17,000	17,750	18,940	19,150	19,500	6.6	4.4	6.7	1.1	1.8
Economy	19,860	21,860	23,730	25,550	27,450	29,850	10.1	8.6	7.7	7.4	8.7
Private domestic organizations	340	350	350	350	350	350	--	--	--	--	--
Domestic yields	36,140	39,210	41,830	44,840	46,950	49,700	8.5	6.7	7.2	4.7	5.9
Abroad	610	635	650	650	650	650	--	--	--	--	--
All spheres	36,750	39,845	42,480	45,490	47,600	50,350	8.4	6.6	7.1	4.6	5.8

situation is favored by the general business cycle upswing, the intensified indirect promotion program by the state, as well as the tax relief measures for R&D in the economy.

A small part of the means generated by the economy finds its way abroad (approximately 1 percent) in order to purchase know-how advances there in a purposeful manner (for example biotechnology). A likewise modest part is expended for external contract research with universities and other research institutions (approximately 2 to 3 percent). Here technology transfer for the benefit of all, without a doubt, could be increased considerably. Research cooperation between the enterprises, a development which can be increasingly observed in other countries for a number of years, is also gaining in significance. The largest part of the funds of the economy remains for R&D purposes in the respective enterprise.

R&D are carried out in the FRG by numerous institutions. The sphere of the economy is by far the largest sphere for R&D. For 1984 we anticipate DM 34.9 billion, which the economy has at its disposal for application-near R&D. The overwhelming part is financed by the enterprises themselves (approximately 83 percent), about 16 percent fall to the share of state funds within the framework of the direct or indirect promotion programs of the Federal Government and the lands, the rest comes from other domestic institutions and especially from abroad. According to the results of the data of the endowment association for 1979 and 1981, approximately two-thirds of the funds up to now have been expended by the large enterprises with more than 5,000 employees. These enterprises received a disproportionate share of the state promotion funds, the enterprises with up to 1,000 employees received less than their share. It is to be expected that precisely the new promotion programs of the Federal Government and the lands will be utilized by these enterprises in order to accelerate the necessary technological adjustment.

Included in the research sphere of the state are the federal and land research institutions, municipal institutions, as well as scientific libraries and museums with their research shares. In these institutions 4.5 percent of the research results are produced. Their research budget, according to our estimate, amounts to about DM 2.25 billion, it is predominantly financed from federal and land funds.

The sphere of the private institutions of a non-profit character includes a multitude of individual research institutions. Among these are, inter alia, the Max-Planck-Institute, the large-scale research institutions, the Fraunhofer Institutes, and the Battelle Institute. Here close to 10 percent of all research output is produced. According to our estimate, funds amounting to about DM 4.9 billion will be available in 1984. The financing comes for the most part from the state (Federal Government and the lands). A small part comes by way of contract research from industry and from abroad. The possibilities for cooperation between these research institutions and industry are far from being exhausted. It is part of a strategy of the positive structural adaptation of the economy to make greater use of the knowledge and experience of these institutes. The Federal Ministry for Research and Technology Progam for the Promotion of External Contract Research aims, inter

alia, in this direction and is intended to give the small and medium-size enterprise an additional incentive to take this path.

The sphere of the universities devotes itself predominantly to basic research. Applied research is carried out above all in the technical disciplines. According to our estimate, funds in the amount of about DM 7.15 billion will be available in 1984 (approximately 14 percent of the entire research budget), which are for the most part generated by the lands and the Federal Government. A smaller part (about 2 to 3 percent) are made available by trade and industry by way of external contract research. Here, too, the main point is to intensify the cooperation between universities and industry. The experience of the last few years in the United States show that here one can indeed anticipate successes in the cooperation.

Table 5. Execution of Research and Development--Federal Republic of Germany, 1979-1984

Sphere	Million DM 1979	%	Million DM 1980	1981	1982	1983	1984	%
Trade and Industry	24,455	66.5	26,500	28,100	30,200	32,300	34,900	69.3
State	1,600	4.4	1,730	2,040	2,200	2,200	2,250	4.5
Private non-profit institutions	3,880	10.6	4,115	4,515	4,890	4,850	4,900	9.7
Universities	5,870	16.0	6,500	6,750	7,100	7,100	7,150	14.2
Sum of domestic spheres	35,805	97.4	38,845	41,405	44,390	46,450	49,200	97.7
Foreign countries	945	2.6	1,000	1,075	1,100	1,150	1,150	2.3
All spheres	36,750	100.0	39,845	42,480	45,490	47,600	50,350	100.0

The FRG has research done abroad for more than DM 1 billion. The funds are provided by the Federal Government (80 percent) and trade and industry (20 percent). The funds of the Federal Government represent for the most part membership fees in international scientific organizations. Vice versa, foreign countries finance research work for about DM 650 million, which is for the most part carried out by industrial enterprises.

While research personnel in the FRG has doubled in the last 20 years, it has stagnated since the end of the 1970's at the attained level. In 1981 375,000 full-time persons were employed, of which approximately one-third is working as researchers (127,000 full-time persons). A further one-third each falls

to the share of technical personnel as well as administrative and supporting staff. Approximately 60 percent of all researchers are working in the sphere of trade and industry.

In international comparison it turns out that the United States and Japan are working with a much higher personnel capacity, in connection with which the strong expansion of scientific personnel in the last 10 years is particularly striking. The United States has expanded its scientific personnel from the lowest level in 1972 with 518,000 persons (full time) to 698,000 in 1982. This is equivalent to an annual increase of 3 percent. In the last 5 years alone, the number of researchers has increased by 4 percent year after year, which corresponds to the real expansion of the research budget. Particularly strong has been the increase of the scientific personnel in industry. Here the annual increase in the last few years has been above 5 percent. At the present time, more than 70 percent of all researchers are employed in the economy.

Japan, too, has increased its entire research personnel (full-time persons) considerably in the last 10 years, that is from 427,000 persons in 1972 to 548,000 persons in 1981. This is equivalent to an annual rate of increase of 2.8 percent. In the last few years alone, the increase was about 5 percent annually. The scientific personnel has been expanded from 198,000 (1972) to 317,500 (1981), which corresponds to an increase of 5.4 percent annually. This strong expansion related both the enterprises and the universities. At the present time, approximately 60 percent of all researchers are employed in trade and industry.

In Table 1 [in the original: in the subsequent illustration], an attempt is made to compare the development of research budgets internationally. The data are partly based on informed estimates. The values in national currency units have been converted into dollar values with the aid of constant exchange rates of the year 1982. The nominal magnitudes were adjusted for changes in prices using R&D price indices (Base: 1975 = 100). It turns out that the FRG makes the largest contribution to the "joint" research budget within the EEC (European 10). Almost $27 billion were spent in 1983 in real terms in the EEC countries for research and development, nearly half them in the FRG. Because of the low real rates of increase, the share has declined slightly, however, in recent years.

Great Britain, France and Italy have launched considerable efforts in recent years to keep pace in the sphere of research and technology and have expanded their nominal research budget by high double-digit rates of increase. Although a large part of this increase was absorbed by high rates of price increases, these countries nevertheless succeeded in gaining ground in real terms.

In the mid-1970's the Netherlands still had twice as large a research budget as Italy, but since that time it has been stagnating at that level. This is also true of the other EEC countries. On the whole, it turns out that the Europe of the 10 combines a considerable research potential. More than 385,000 researchers have more than $25 billion in research funds at their disposal; this, however, more in an additive than integrative manner, and this is where the special weakness lies. We must add that the dynamic has declined

in recent years. From the former 4 percent of real growth per year, the research budget of the European 10 has grown by only 2.7 percent during the period of 1979 to 1983, with the number of researchers stagnating to a large extent.

Table 6. Research Personnel (Full-Time Persons in 1,000)

Country	Year	Sector	Total	Researcher	Technical Personnel	Other
FRG	1979	Trade & Industry	238.0	73.5	75.8	88.7
		University	70.4	29.0	24.3	17.1
		Other Institutes	54.8	19.5	15.4	19.9
		Total	363.2	122.0	115.5	125.7
	1981	Trade & Industry	242.5	76.4	77.1	89.0
		University	75.3	30.9	26.5	17.9
		Other Institutes	57.5	19.9	16.4	21.2
		Total	375.3	127.2	120.0	128.1
USA	1979	Trade & Industry		434.9		
		University		91.9		
		Other Institutes		94.2		
		Total		621.0		
	1981	Trade & Industry		482.0		
		University		96.5		
		Other Institutes		94.5		
		Total		673.0		
Japan	1979	Trade & Industry	272.3	157.3		
		Univeristy	173.0	96.7		
		Other Institutes	50.7	27.9		
		Total	496.0	281.9		
	1981	Trade & Industry	307.5	184.9		
		University	180.9	102.6		
		Other Institutes	59.9	30.0		
		Total	548.3	317.5		
France	1979	Trade & Industry	123.7	32.5		
		University	45.8	23.7		
		Other Institutes	61.3	16.7		
		Total	230.8	72.9		
	1980	Trade & Industry	126.5	33.5		
		University				
		Other Institutes				
		Total				
Italy	1979	Trade & Industry	46.7	18.4		
		University	28.1	20.1		
		Other Institutes	19.8	7.9		
		Total	94.6	46.4		
	1981	Trade & Industry	50.4	19.5		
		University				
		Other Institutes				
		Total				

By comparison, the United States has expanded its research budget year after year by slightly more than 4 percent in real terms, with an equally strong expansion of the number of researchers (scientists and engineers). The state and industry had an approximately equal share in this. The important forces stimulating the research system here lie, as far as the American Federal Government is concerned--and only for the latter are research tasks shown--in the spheres of defense, as well as aviation and space research. These two functional areas at the present time account for approximately 75 percent of the research expenditures of the American Federal Government, while energy research has strongly declined in the past few years and was concentrated on long-term program components. Important research emphases within the first two areas are microelectronics and material technology.

Added to this are intensified efforts to support scientists and engineers. For this purpose, additional means are made available to equip universities and national research institutions with the latest scientific instruments and computers. It is further a declared goal to continue to strengthen the co-operation between researchers in industry, the universities and national research laboratories, in order to bring together the scientific expertise that is necessary to cope with the technical-economic challenges.

As far as the sphere of trade and industry in the United States is concerned, it is becoming clearly evident that in many economic sectors the growing competition from abroad is the most important motive for the increase of the R&D budget by 2-digit rates. Nominal increases between 15 and 20 percent are not rare. One of the most remarkable indications since the beginning of the 1980's is the collaboration of firms and research institutes in the sphere of the development of leading technologies. The tax relief measures in effect since 1981 for the promotion of R&D constitute a considerable incentive for many firms to increase the research budgets.

In Japan the promotion of research and technology continues to be one of the most important goals. It is generally recognized that this is vitally necessary for Japan in order to achieve further economic progress. This applies particularly in view of the fact that Japan has closed the technological gap of the past to a large extentand now must pursue independent lines of technological development (transition from technology user to technology producer country).

Moreover, in Japan, as a matter of tradition, research and technology policy is an integral component of the policy of industrial structure, so that research and development expenditures are used not only for the development of new high-technology industrial spheres (knowledge intensification), but also for the restructuring of traditional branches of industry with capacity utilization problems (revitalization, technology diversification).

Altogether approximately 3 percent of the social product [national product] annually are to be raised in the near future for R&D. This explains the high 2-digit nominal rates of increase in the last few years. After deduction of the price increases, almost 7 percent annual increase in real terms still remained. If the tempo of this expansion continues, the goal will be

achieved, in the course of which the most efficient possible use of R&D funds within the meaning of national objectives is favored through well-coordinated harmonization mechanisms in the private economy and between state and industry. The share of private trade and industry in the total R&D expenditures, at the same time, will remain invariably high (2/3).

8970
CSO: 3698/498

SCIENTIFIC AND INDUSTRIAL POLICY

SWEDEN ALLOTS 3 BILLION KRONOR FOR R&D IN HIGH TECH

Information Technology, Aeronautics Stressed

Stockholm TEKNIK I TIDEN in Swedish Spring 1984, pp 1, 2

[Article by Sigvard Tomner, director-general, STU (National Swedish Board for Technical Development):"STU Breaking New Ground"]

[Text] Three billion kronor will be allotted to research and development during the next 3 years. This appears from the government's research policy proposition. The funds allotted to research will increase by 420 million kronor.

This, however, is merely the beginning of a long-term development, the objective of which is to strengthen Swedish industry.

The government venture, to a certain extent, involves new directions to be taken by STU. The belt will have to be tightened in some areas, and a certain rearrangement of priorities, therefore, will become necessary.

Information technology, factory technology, biological engineering, aeronautics, textile technology and oceanological technology are areas which will be stressed under the STU program.

Important areas which will receive less funds are, among others, transport technology, soil engineering, nuclear waste technology and reprocessing technology.

The government's research proposal has now been presented to the Swedish parliament and will be dealt with in the usual manner during the spring. The objective has thus been achieved of having research questions of all departments dealt with jointly.

This is of particularly great importance for the broad activities of the STU. It is also ascertained that the guidelines for STU's cooperation with the various sector authorities belong under practically all departmental sections.

The overall purpose of such a cooperation is naturally to make possible the identification of a joint view on the most urgent needs and possible measures.

STU obviously takes a very positive view of such further expanded cooperation.

The renewal proposal of the minister of industrial affairs has also been presented to the Swedish parliament. On the basis of the government's position on and proposed resources for the activities of STU, we at STU are now working intensively on our working plan for the period 84/85 - 86/87. It goes without saying that the first budget year will thus become the object of extremely detailed analyses.

In the presentation shown below only the areas of the activities of STU which comprise project and project support, i.e. STU's external activities, will be dealt with. Altogether, this affects approximately 4,000 persons, more or less equally distributed among technical universities and the trades and industries.

The efforts of STU within the energy sector will not be included below. Here STU has a separate estimate. It should, however, be pointed out that efforts to save energy will become an increasingly important factor in all efforts for technical development.

Prerequisites and Adjustments of Resources

According to the directives applying to the activities of the authorities, STU has presented the government with proposals at alternative levels. STU has thus indicated the priorities within a totally seen unchanged ambition level as well as the efforts proposed within an alternative of increases, respectively the areas among the activities which will have to be excluded if the alternative of reductions is adopted.

The point of departure for STU is now, according to the proposals, to plan the activities on the basis of a largely unchanged ambition level. A national microelectronics program is proposed to be given increased resources in the form of separate estimates, as far as industrial development is concerned.

The government's proposals for areas which are given priority follow two main lines, viz.:

partly in terms of technology areas with regard to need and significance for the future development of Swedish industry;

partly adjustments directed toward various groups of recipients (customer groups).

The priorities given to areas of technology will bring about major developments in information technology, factory technology as well as biological engineering.

In addition, separate measures are proposed within the areas of aeronautics, textile technology and oceanological technology. A large number of areas are stressed as important and with largely unchanged ambition levels.

These areas are:

Materials testing

Pulp technology and paper technology

Wood-working techniques

Chemical engineering

Technology for public health and sick care

Reduced Resources--Cooperation Important

The above-mentioned measures which largely correspond to STU's own proposal in the appropriation report will, with regard to the government's proposal, have the effect that a number of rather important areas will receive reduced resources.

These areas are:

Materials handling

Food technology

Mineral resources technology and geotechnology

Nuclear waste and reprocessing technology

Work environment technology

Forest technology.

As far as the above-mentioned areas are concerned, they include areas where the very cooperation with various sector authorities is stressed specially in the government's proposals. It, therefore, becomes particularly necessary, in view of the very limited economic resources, to seek to achieve the best possible effect through good cooperation.

As far as the emphasis on various consumer groups is concerned, in its research proposal the government has proposed that 30 million kronor be shifted from the STU program for development work to the program for educational development. Of these resources, 20 million kronor will be earmarked for "the work of a technical research council within STU."

The selection of project priorities within this framework will be undertaken by a group composed of researchers and on the basis of technological inter-scientific criteria. The government intends to provide further directions later on.

The government's proposal to increase the educational program at the cost of the development program means increased emphasis on the part of STU on the university sector. This actually is in accordance with STU's own proposal, but as it has to be done within the budgetary framework proposed by the government, there will be negative consequences for the development program.

The form of support arranged by STU in cooperation with the university sector of concentrated framework programs for the long-term educational needs of industry is proposed to be continued to the same extent as hitherto.

The framework programs are also to a considerable extent focussed on the areas of technology which have been given priority and are perceived as having an enormous effect and as being of great importance for post-graduate education.

The collective research carried on at 17 institutes and carried through primarily at university institutes and with joint financing between state (STU) and various trades or industrial groups, is, in various contexts, mentioned in the proposal as a good form of cooperation between industry and state toward common goals.

However, as far as economic resources are concerned, the proposal of the government states that STU must endeavor to achieve a reduction of state subsidies within well-established areas in order thus to release resources for other areas.

Emphasis Primarily on New Technology Enterprises

As far as the private sector of the economy is concerned, STU's efforts for product development must focus on technology-based newly established enterprises with high growth potential.

STU must thus also in particular take into consideration the ideas of invention which may form the basis for the formation of such enterprises. STU, however, is urged not to support product development projects in major enterprises with ample resources.

During recent years, this has already been done to a very limited extent and then often coupled to cooperation among various universities or as dissemination of technology to minor enterprises.

Consequences and Measures

The efforts and the activities which the state authorities make STU responsible for are based on a trusting cooperation with a wide circle of interested parties.

It, therefore, is very important for this large circle of contributors also to be informed of and to understand the limitations which, on account of a needed restrictive economic policy, will have to apply also to STU. In the research proposal, the government has proposed increased resources for the university sector and for basic research in general, and STU warmly welcomes these measures.

I have above attempted to explain the main lines proposed for STU's area of work. This involves considerable rearrangements of priorities. I can foresee that STU therefore will be forced to reject many actually interesting proposals, which we regret. Finally, I shall mention some areas where the demand for the cooperation of STU is expected to exceed the supply of resources.

Within the areas of high priority and, in particular, within the areas of electronics, computer technology and biological engineering, the levels of activity within universities and in industry have increased sharply. There has not least been an increase in newly established enterprises. The pressure of demand on STU in the form of very qualified projects is already approximately two to three times beyond the scope of resources. Despite increased resources in these areas, the pressure of demand will probably increase even further.

On account of the needed rearrangements of priorities, the possibilities for STU to grant support to sectors outside the areas which have been given particular priority, will become limited. There is a risk that funds will be lacking entirely for certain areas. It is my hope that the increased support for the basic resources of universities and for the activities of the research council within STU will ease the situation somewhat.

A reduction of the participation of the state in the collective research programs may, furthermore, bring about a lower rate of involvement on the part of industry. This will then counteract the ambition on the part of the government to improve the conditions for such participation.

The most important element in the cooperation between the major enterprises and STU is not the direct support, if any, of projects of a risk assuming nature. On the other hand, the evaluation by the major enterprises of future needs and development trends is of extremely great value, for example, in the preparation of framework programs within the university sector and thus for STU's planning activity.

Project support for small enterprises and individuals must, according to the guidelines proposed by the government, be directed toward projects with a high growth potential and with a view to stimulating new enterprises.

With regard to the other priorities of the government, this has the effect that STU will get an approximately 25 percent lower economic framework for this activity during 1984/85 than in 83/84. STU, therefore, will have to concentrate its support on the early stages and presuppose increased cooperation with regional development funds and venture-capital enterprises.

It will thus not be possible to comply with the often expressed desire for STU to continue its support farther into 'the development chain' except in exceptional cases.

The areas where other authorities are urged to cooperate with STU in the form of joint projects are as a rule areas which, from the point of view of the industrial policy are not given high priority. STU's economic resource frameworks become very limited there.

STU and other authorities have received increased resources for procurement of technology. It, therefore, becomes urgent to use this form of support, to an increased extent, for efforts in the form of cooperation.

In the course of the coming years, big demands will be made on STU and our staff. With relatively reduced resources, both economically and as far as our staff is concerned, we shall have to meet the big expectations which the government and our customers have of us. We shall have to make great efforts to become even more effective.

Industrial Innovation Funds

Stockholm TEKNIK I TIDEN in Swedish Spring 1984 p 4

> [Text] For the first time ever, Sweden has got a joint research policy. The state will allot a total of approximately 3 billion kronor to research and development (R & D) in 3 years. This appears from the research policy proposal of the government which is supported by 14 ministers, i.e. two-thirds of the government.

Even if research will receive increased funds totalling approximately 420 million kronor, the proposal is merely the start of a long-term development, says Minister Ingvar Carlsson. The purpose is to reinforce Swedish industry.

"Long-term development of knowledge" and "quality" are terms which keep recurring in the government's presentation of the proposal. As a result, the state authorities will launch an offensive in the area of basic research, quantitatively as well as qualitatively. There is also a clear control of the allotments.

Environment control, biological engineering, electronics, and materials technology are among the heavy areas of knowledge which the government gives the highest priority.

With a view to the increased profits of the enterprises, the government also wants for industry to participate in the costs of basic research. This question is dealt with in discussions between the government and industry.

Research and development now account for approximately 2.5 percent of the GNP, i.e. well over 18 billion kronor. A total of 15 billion kronor is spent on applied research work.

Among the new elements of the government proposal may be mentioned the plan to improve the research environment through the allotment of 400 million to new construction.

The exchange between Swedish and foreign researchers will also be facilitated. Swedish researchers will be given better possibilities of traveling abroad. Foreign experts within Swedish enterprises and universities will be necessary in order to develop the basic research.

However, the high pressure of taxation in Sweden has long been a problem for this important international exchange. The government, therefore, is now rapidly deliberating the question of tax relaxations for "a limited number of scientists."

Industrial Innovation

Immediately after the large research policy proposal, the government presented a new industrial policy proposal. A total of 1.1 billion kronor will be spent in 3 years on industrial innovation.

The majority of the funds will go to new projects and technical development. In its proposal, the government puts great emphasis on the importance of starting many new enterprises in the country.

"New enterprises form the basis for a positive change and innovation of Swedish industry, said Minister of Industry Thage G. Peterson in his presentation of the government proposal.

In order to help small enterprises, the government proposes the following allotments, among others:

A total of 135 million kronor will be allotted to the National Industrial Board for the support of small enterprises with development possibilities, for example through the aid of consultants.

A total of 62 million kronor will be allotted to a new research contribution to small enterprises.

A total of 100 million kronor will be allotted to a fund granting aid to small enterprises. Such a fund will be able to help minor enterprises with risk capital.

A total of 15 million kronor will become the initial contribution to a newly formed Design Center. The government finds that design is an area in which Sweden has been lacking behind.

In addition, another 95.5 million kronor will be allotted to the microelectronics program which is carried on in cooperation with several major enterprises, 15 million kronor to the development of highly automated production systems for the engineering industry as well as another 600 million kronor for the Industrial Foundation to be granted in the course of 3 years.

7262
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FUNDING PROGRAMS OF FRG RESEARCH, TECHNOLOGY MINISTRY IN 1983

Leinfelden-Echterdingen EEE in German May 84 p 2

[Article: "The BMFT Takes Stock: Funding Catalog Published." JPRS will be publishing excerpts from this catalog; for excerpts from the 1982 catalog see JPRS-WST-84-006 of this series dated 13 Feb 84, pp 33-63.]

[Text] Bonn (r). The Ministry for Research and Technology participated in the funding of research and technological development during 1983 with about DM 6.6 billion. In comparison with the fiscal year of 1982 this is a drop of about DM 370 million (about 5 percent). The reduction of direct project funding of projects that are carried out by the industrial sector comes to 21 percent, which is also reflected in the number of newly started projects.

In 1982 in this sector 982 new projects were approved, but in 1983 there were only 793 which corresponds to a drop of 19 percent.

In the area of the indirect-specific funding for the field of "application of microelectronics" the amount of funding could be raised from DM 87.5 million in 1982 to DM 151.3 million in 1983.

The format of the catalog corresponds to that of the proceding years: full overviews for rapid orientation are placed in the beginning. Detailed information is included in the main section of the catalog, which is divided systematically into the 19 funding categories of the program guidelines. Within a category each project is identified as an individual project that is funded directly by the BMFT [Ministry of Research and Technology] or through the project proposers, or as an institutional funding.

Two graphs, eight tables, and a list of the biggest projects provide information on the scope and structure, range of funding, and regional distribution of the BMFT research funding in 1983; these are placed in front of the main section of the catalog. Both graphs--"Full overview by funding areas" and "Individual projects in the Laender/abroad"--make possible a comparison of 1982 with 1983.

In particular the overviews present the comparison of individual with institutional funding, of basic, applied research with development, and the regional distribution by Laender/abroad.

The indirect-specific funding is presented in the relevant tables as totals. In a supplementary list all the projects with a funding allocation in 1983 of 5 million marks or more are included.

One copy of the funding catalog for 1983 can be obtained without charge only with a written request to the Ministry for Research and Technology, Report 133, Heinemannstr. 2, 5300 Bonn 2.

12446
CSO: 3698/505

SCIENTIFIC AND INDUSTRIAL POLICY

FRG INSTITUTE TO FUND SMALL, MEDIUM FIRMS

Duesseldorf VDI NACHRICHTEN in German 8 Jun 84 p 1

[Article by E.S.: "State Supports Contract Research"]

[Text] New products and new processes are the key to being competitive tomorrow for small and medium firms too; nevertheless, there is often a lack of know-how and the necessary personnel to take advantage of modern technology. A remedy is available, however: outside contract research.

Of course, research and development is unfortunately now connected with a sometimes not exactly small technical and financial risk, for which reason the Fraunhofer-Gesellschaft in Munich has a special funding program. This "MU Program" (MU stands for Mittlere Unternehmen [medium firms]) is based upon the resources of the Federal Government and the Laender and provides for the partial funding of research contracts that are made between the medium and small firms and the Fraunhofer Institutes. During a press conference it was learned that the subsidies cover about four- to six-tenths of the total cost of a research project.

Who can hope for funding under this program? The upper limit reaches an annual turnover of DM 500 million, and naturally the firm concerned must manufacture in the Federal Reupblic. The object of the research proposal must be a project or a process that is technically novel and efficient, for which there is a recognized need in the marketplace, and which can then be developed by the firm requesting the funding. If the cited conditions are met, then a firm can directly approach a Fraunhofer Institute or even the Fraunhofer main office in Munich and disclose the pertinent points of the research project.

In 1984 about 4 million marks are available for funding; in 1985 it should reach 5 million marks. The MU Program has been in effect since 1976 and includes 235 projects so far, whose total cost came to about 51 million marks, of which 26 million is funding. The costs of the individual projects lie between 50,000 and 1 million marks; the average amount lies at DM 220,000.

So far 55 percent of the funding went to firms with an annual turnover of up to DM 50 million. At the top of the list are manufacturers of machinery who were allotted about one-third of all the projects. This then is followed by

precision mechanics and optics, the chemical and pharmaceutical industries, and electrical engineering. Of the 235 projects cited, 140 are already completed, of which four-fifths provided the development of newer, or the improvement of, existing products. One-fifth led to new processes, among which were those that yielded more economical products.

12446
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SCIENTIFIC AND INDUSTRIAL POLICY

FRG SEMINAR ON FOUNDING HI-TECH BUSINESSES, VENTURE CAPITAL

Duesseldorf HANDELSBLATT in German 12 Jun 84 p 6

[Article: "Ministry for Research and Technology/German-American Seminar Suggested by Chancellor. Technology-Oriented Business Start-Ups"]

[Text] hjs Bonn--A German-American seminar on the subject of technology-oriented business start-ups and venture capital will be held from 13 to 15 June in Bonn.

The German Government expects valuable suggestions for discussion within the FRG to result from the seminar, to be held jointly by the Ministry for Research and Technology and the Konrad Adenauer Foundation with support from the American Embassy.

The idea for this German-American seminar is the result of talks between Chancellor Helmut Kohl and American Ambassador Arthur F. Burns, as well as discussions held by Minister for Research and Technology Heinz Riesenhuber one year ago in the U.S.

After the opening of the seminar by Minister Riesenhuber and welcoming statements by Ambassador Burns and the Chairman of the Konrad Adenauer Foundation, Bruno Heck, representatives of successful American hi-tech companies will report on their experiences. Reports are also to be presented to the effects of venture capital.

The agenda for the seminar also includes a comparison of the general requirements for hi-tech companies in the U.S. and the FRG to be presented by A. Graf Matuschka of Techno Venture, and a report presented by Professor M. Syrbe of the Fraunhofer Society on the current state and future prospects of production-ready technologies in the FRG.

On the second day, the seminar participants will be divided up into three working groups which will deal with the topics of "Entrepreneurship," "Management of Hi-Tech Businesses" and "Innovative Financing." After an evening reception by Ambassador Burns on the final day, the results of the working groups will be discussed in a combined group. The Minister for Economics Otto Graf Lambsdorff will also speak on the potential for German-American cooperation in the field of new technologies. Minister for Research and Technology

Heinz Riesenhuber will report on the results of the German-American seminar in the form of a concluding press conference.

The report on successful hi-tech businesses in the U.S. to be presented by D. Packard of Hewlett-Packard will include a discussion of the role of government assistance and specific management problems, and will investigate the question of how access to new technologies can be maintained and how financing changes can be brought about.

The primary topics to be discussed in the report on venture capital in the U.S., which will be presented by E. Kleiner of Kleiner, Perkins, Caufield & Beyers, will be a general overview of the subject of venture capital, its current status, its structure and operation, and requirements for successful investment. In his comparison of the general requirements which must be met by hi-tech businesses, Mr. Matuschka will discuss corporate structure, the business climate and social issues, management potential, power in the marketplace, and financing questions and legal requirements.

12644
CSO: 3698/496

BRIEFS

FRG FUNDS FOR PRODUCTION TECHNOLOGY--In the first quarter of 1984, 1,000 applications for indirect-specific support in the production engineering program have been received. Because of the continuing uninterrupted flow of applications, the Federal Ministry for Research and Technology (BMFT) has decided to increase the program by DM 100 million--this was reported by the project sponsor for production engineering in the nuclear research center in Karlsruhe. For the period 1984 to 1987 thus a total of DM 450 million will be available.

At the present time, 1,214 applications have been received, including 1,059 on the subject of "computer-aided design" and "computer-aided manufacturing" (CAD/CAM). There are 155 applications on the subject of manipulation systems/industrial robots. The distribution of the applicants by enterprise size produces a central point of interest for CAD/CAM at an enterprise size of 200 to 500 staff members (24 percent of these applications). Above all, smaller enterprises with up to 50 employees are interested in the application of industrial robots (44 percent of the respective applications). For all that, 18 percent of the applications for CAD/CAM and 10 percent of the applications for support of industrial robots fall to the share of large-scale enterprises with more than 1,000 employees. [Excerpt] [Duesseldorf VDI NACHRICHTEN in German 25 May 84 p 1] 8970

FRG'S SALZGITTER SELLS CHEMICAL PLANT TO USSR

Duesseldorf VDI NACHRICHTEN in German 25 May 84 p 25

[Text] An agreement on the delivery and construction of a chemical plant complex was signed these days between the Soviet Tekhmashimport Foreign Trade Association and the Engineering and Contractorfirma Salzgitter, which belongs to the federally-owned Salzgitter Company. After protracted, intensive negotiations, Salzgitter received the order against strong international competition. The chemical complex consists of complete production facilities for the production of carbon monoxide from natural gas for the synthesis of 40,000 tons per year of formic acid (100 percent) through catalytic reaction of carbon monoxide and water, as well as for the manufacture of canisters and other packing drums which are needed for the filling and transport of the forbic acid. The value of the installations to be delivered for the plant to be built in Saratov (Ukraine), the technical documentation, and the production licenses amounts to close to DM 130 million.

Forbic acid is used in the chemical industry, in addition it is to be used as a conservation substitute for the storing and transport of food and feed products.

In the realization of this project, the forbic acid synthesis process developed by Soviet chemists and engineers in the experimental plant in Borislav (Ukraine) is used. The State Scientific Research and Planning Institute of the Chlorine Industry of the Soviet Ministry of Chemical Industry and the All-Union Litsenzintorg Association, through this contract, arranged for cooperation with Salzgitter in regard to the use of Soviet technology, which may be exemplary for future industrial projects. In addition to the granting of the license, further Soviet organizations and plants will be engaged in the installation and subcontracting of equipment. It is envisaged that Salzgitter and the indicated Soviet organizations will also cooperate in third countries and offer the Soviet technology internationally.

In the interest of the earliest possible production of forbic acid, the planning work in the Soviet Union and in the Federal Republic of Germany has already begun. Among the approximately 120 consumer countries, the Soviet Union has for years been one of the largest export customers of the Salzgitter Company. The share in the export sales of the company in 1982-1983 came

to DM 450 million, or 12 percent. Steel and installation construction are the supports of the business; thus far Salzgitter has supplied 11 chemical plants to the Soviet Union and furthermore has built the passenger terminal building of Sheremetyevo II. Salzgitter also has a share in the construction of the Oskol Metallurgical Combine.

8970
CSO: 3698/506

TECHNOLOGY TRANSFER

SWEDISH MINISTER COMMENTS ON HIGH-TECH EXPORT RESTRICTIONS

Stockholm DAGENS NYHETER in Swedish 18 Jun 84 p 5

[Article by Mats Hellstrom, Minister of Trade of Sweden: "Strengthened U.S. Law Interrupts Our Trade"]

> [Excerpts] A strengthening of the American restrictions which regulate the export of high technology has been discussed recently in the United States. It could make trade between Sweden and the United States more difficult, and have serious consequences for Swedish firms, writes Minister of Trade Mats Hellstrom. Prohibition of the kind which the United States is bringing to bear in this area usually leads to the growth of an illegal market.

For some time in the United States there has been discussion of strengthening the restrictions which regulate the export of high technology.

In our country there is broad political unity both as to the neutrality policy and the advantages of free trade. Small countries such as Sweden, which depend on foreign trade, are hit harder than the major powers and large trade blocs by protectionism and impediments to trade. We have a major commitment as well as self-interest in expanded free trade.

For its part the United States considers that the nation's security policy requires that the export of high technology from West to East be limited. This is mostly to protect the technological advantage held by the West.

By means of the so-called COCOM cooperation allies of the United States have during recent decades participated in the blockade. Sweden, as a neutral nation, stands outside this cooperation. There is no special prohibition or limitation on the export of Swedish technology to other countries except of course for war material and nuclear energy equipment.

The American embargo policy has, however, had reactions in Sweden as well as other countries. Above all it has affected the situation for the Swedish firms which import advanced technology from the United States. A large

number of these products have double areas of utilization, they can be used for both civilian and military purposes. The American embargo restrictions include all such "dual use" technology which is considered to have a security effect.

Some years ago Swedish industry considered--against the background of the growing debate over a strengthening of restrictions in the United States--that there was need for special security protection for parts of the embargoed technical imports to Sweden, primarily large computer installations. The Defense Material Administration (FMV) therefore on a consultant basis formed an internal Swedish security arrangement for the industrial firms which require it. The arrangement is so designed that it can be used for all sensitive technology regardless of where it comes from. Swedish industry has a strong incentive to live up to the recommendations issued by the FMV.

The voluntary security arrangement for firms does not conflict in any way with neutrality policy. It is naturally important that a Swedish firm adheres to the terms agreed to when it signs a contract. A country can demand that a product which is developed in the country and which a Swedish firm wants to buy is placed under security protection.

Prohibitions of the kind which the United States is bringing to bear in this area usually lead to the development of an illegal market. This has also happened when dealing with the export of Western technology to the East--a fact which we in Sweden have had very visible evidence of recently.

For individuals who want to make large amounts of money by smuggling embargoed high-technology products from the United States, Sweden can at first glance perhaps offer possibilities as a transit country, since we do not participate in COCOM cooperation.

It is obvious that the economic investments are unusually high in this type of traffic. As shown in the report of the war material inspector, the containers contained much qualified war material, in the form of electronics material and other things, with both hardware and software which can be used in fire control centrals and for control of long range missiles, etc.

It is a strong Swedish interest that as a neutral nation we are not used for smuggling business of this kind. Whatever opinion one has of the American embargo policy, we can not accept that it leads to Sweden being the transit area in this connection. It is obviously important for us that Swedish territory is not used as an operational base for international gangs. Therefore customs officials have also increased their guard in this area.

Sweden has been able without great difficulty to manage the situations which have arisen because of the American export prohibition. We have also, however, confirmed that there is a risk that trade between Sweden and the

United States can be impeded if the American restrictions are strengthened. Our government has repeatedly during past years sent its objections to the American Government.

We maintain that the United States should not take steps which will interfere with our trade. Many other governments and hundreds of firms in the United States and West Europe have also taken up the issue with the American administration. The problem applies by no means only to Sweden, but to most countries which trade with the United States.

It is not only Swedish and other foreign firms which would be hit by a strengthening of the American restrictions. It would also hit American firms. Research and development has through history gone forward mainly through exchange of knowledge and information. Therefore it is in the long run obstructive for a country if its research climate is instead marked more by efforts to hold back information about new developments. A very lively debate is now going on about this in the United States.

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